21 Smooth-hounds in the Northeast Atlantic

21.1 Stock distribution

Three species of smooth-hound (Triakidae) occur in the ICES area.

Starry smooth-hound *Mustelus asterias*

This is the dominant smooth-hound in northern European waters. The development of molecular genetic identification techniques has allowed the reliable identification and discrimination of NE Atlantic *Mustelus* species (Farrell *et al*., 2009). Subsequent studies involving the collection of 231 *Mustelus* from the Irish Sea, Bristol Channel, Celtic Sea and west of Ireland, identified all to be *M. asterias* (Farrell *et al*., 2010a, b). Studies of *Mustelus* samples (n = 504) from the North Sea and English Channel (McCully Phillips and Ellis, 2015) also found all specimens to be *M. asterias*.

There are several on-going tag-and-release programmes for *M. asterias* (e.g. Burt *et al*., 2013 WD). Sportvisserij Nederland, in conjunction with Wageningen Marine Research, have a tagging programme with anglers in the Dutch Delta (Brevé *et al*., 2016, 2020). The latest study reported that 3699 *M. asterias* were tagged, and 220 recaptures reported (Brevé *et al*., 2020). Recapture positions showed a circannual migration, with fish spending the summer in the southern North Sea and overwintering in the English Channel and Bay of Biscay, suggesting a degree of philopatry (Brevé *et al*., 2016, 2020). These behaviours are supported by electronic tagging studies conducted by Cefas (Griffiths *et al*., 2020). Cooperative large-scale analyses of all available tagging data are required to further understand population stock structure of *M. asterias* in the Northeast Atlantic. Tagging studies from the more southern parts of the distribution range could usefully be undertaken.

In the absence of more detailed studies on stock identity, WGEF considers there to be a single biological stock unit of *Mustelus asterias* in the continental shelf waters of ICES Subareas 4, 6–8. The southern limits are uncertain.

Common smooth-hound *Mustelus mustelus*

This species occurs along the west coast of Africa, Mediterranean Sea and western Europe. It is believed to be the more common species in the southern parts of the ICES area, but the northern limits are uncertain. No confirmed specimens have been found in northern parts of the ICES area in recent years and historical records are questionable, especially those records north of the Bay of Biscay. Separating these two species on the presence or absence of spots is unreliable (Compagno *et al*., 2005; Farrell *et al*., 2009), and information and data from northern Europe referring to *M. mustelus* likely refers to *M. asterias*.

Black-spotted smooth-hound *Mustelus punctulatus*

This species occurs in the Mediterranean Sea (Quignard, 1972) and off NW Africa and the southernmost part of ICES Division 9.a is believed to be the northern limit of this species.

Generic issues

The species composition of smooth-hounds in Subareas 8–9 is unclear, and species/stocks in these areas likely extend into the northern part of the CECAF area and Mediterranean Sea. Given species identification issues and that some species and/or stocks may extend beyond the ICES area, the identification of management unit(s) would need appropriate consideration.

Given the problems in separating *M. asterias* and *M. mustelus* and that data for these two species are confounded, data in this chapter are generally combined at genus level. Whilst assessments conducted by WGEF are based on *Mustelus asterias*, management advice should be applied at the genus level, so as to avoid potential identification problems associated with management and enforcement.

21.2 The fishery

21.2.1 History of the fishery

Smooth-hounds are a seasonal bycatch in trawl, gillnet and longline fisheries. Though they are discarded in some fisheries, others land them as bycatch, depending on market demands. Some may also be landed to supply bait for pot fisheries.

Smooth-hounds are also a relatively important species for recreational sea anglers and charter boat fishing in several areas, with anglers and angling clubs often having catch-and-release protocols, particularly in the Celtic and North Sea ecoregions.

21.2.2 The fishery in 2020

The impact of the COVID-19 pandemic on fishing activity, though so far unquantified, may be assumed depending on national or local restrictions in place, to have reduced fishing effort in 2020.

Anecdotal information from the UK fishing industry suggests that increased landings of smooth-hounds in recent years are partly to supply market demand for 'dogfish', given the current restrictions on spurdog. *M. asterias* is also of increasing importance to some inshore fisheries, given restricted quotas for traditional quota stocks and anecdotal information suggests that, locally, the market value has increased beyond that of skates and rays.

21.2.3 ICES Advice applicable

ICES first provided advice for this stock in 2012 for 2013 and 2014 (which was reiterated for 2015), stating that "*Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 4%. Because the data for catches of smooth-hounds are not fully documented and considered highly unreliable (due to the historical use of generic landings categories), ICES is not in a position to quantify the result*".

In 2015, ICES advised that "*when the precautionary approach is applied, landings should be no more than 3272 tonnes in each of the years 2016 and 2017*". This was based on a survey-based (Category 3) assessment, with the stock size indicator based on four survey indices.

In 2017, ICES advised that "*when the precautionary approach is applied, landings should be no more than 3855 tonnes in each of the years 2018 and 2019. ICES cannot quantify the corresponding catches*". This was based on a survey-based (Category 3) assessment, with the stock size indicator based on three survey indices.

In 2019, ICES advised that "*when the precautionary approach is applied, landings should be no more than 4626 tonnes in each of the years 2020 and 2021. ICES cannot quantify the corresponding catches*".

21.2.4 Management applicable

There are no specific management measures for smooth-hounds.

EC Council Regulations 850/98 for the `conservation of fishery resources through technical measures for the protection of juveniles of marine organisms' details the minimum mesh sizes that can be used to target fish. Although other dogfish (*Squalus acanthias* and *Scyliorhinus* spp.) could be targeted in fixed nets of 120–219 mm and >220 mm mesh size (in regions 1 and 2), *Mustelus* spp. would be classed under 'all other marine organisms', and so can only be targeted in fixed nets of >220 mm..

21.3 Catch data

21.3.1 Landings

No accurate estimates of catch are available for earlier years (Table 21.1; Figure 21.1), as many nations that landed smooth-hounds reported an unknown proportion of landings in aggregated landings categories (e.g. 'dogfish and hounds *nei*').

ICES estimates, following WKSHARK2 (ICES, 2016a), indicate that landings have been over 3000 t since 2005 (Table 21.2). The main nations exploiting smooth-hounds are France and the UK. The English Channel and southern North Sea are important fishing grounds.

Although landings from Spain show a decrease since 2015, this is mostly due to unavailable data from FAO areas 34 and 37, which represented on average ca. 11% and 30% of total landings reported to WGEF for this country during 2005–2014, respectively.

Landings outside the FAO area 27 currently available to WGEF are considered negligible when accounting all countries combined data during 2005–2020 (ca. 0 to 2%).

Landings from the Netherlands show an increase in 2019–2020 which may be partially linked to an increase in fishing effort by fly shoot (seine) fisheries.

Species-specific landings for the various species of *Mustelus* are not considered accurate, and data have been collated at genus level. These values are likely underestimates, given that some nations still have some landings of 'dogfish and hounds *nei*'.

21.3.2 Discards

Although discards data are available from various nations, data are limited for some nations and fisheries. Seven countries reported preliminary estimates of discards for 2009–2020, however data show high inter-annual variability by country and thus, further data analysis should be undertaken if data to be used in the assessment (see also Section 1.14). Given the seasonality of catches in some areas, and that *M. asterias* is often taken by inshore vessels where observer data can be more sporadic, further studies to evaluate the most appropriate methods of raising data from observer trips to fleet level are required if catches are to be estimated appropriately.

In addition, discards data collection is likely to have been affected by COVID-19 national restrictions in place during 2020 (e.g. social distancing) hence, a decrease in the number of samples comparatively to previous years may be assumed, though the impact is yet to be quantified. Therefore, these data should be viewed with caution.

Earlier studies have indicated that juvenile *M. asterias* are often discarded (Figure 21.2), although the survival of these discards has not been evaluated (Silva and Ellis, 2019). *M. asterias* taken by beam trawl and *Nephrops* trawl were composed primarily of juveniles and sub-adults (<70 cm L_T), and nearly all were discarded. Gillnet catches were comprised primarily of fish 70–110 cm L_T, with fish <60 cm L_T usually discarded. Otter trawl catches covered a broad length range, and *M. asterias* <60 cm L_T were usually discarded. The absence of full retention at length in these gears may be due to various factors (e.g. catch quality and local market value) influencing the discarding behaviour of fishers.

Silva and Ellis (2019) also noted that a greater proportion of *M. asterias* were retained since landing opportunities for spurdog had become restrictive. In the years 2002–2009, the retention of *M. asterias* ≥70 cm L_T was 59% and 44% in gillnet and otter trawl fisheries, respectively. In the period 2010–2016, however, retention increased to 85% (gillnets) and 66% (otter trawl). In addition, length at retention for otter trawl dropped from 41 cm L_T (2002–2009) to 34 cm L_T (2010–2016).

WKSHARK3 undertook further exploratory analyses of discards data, with the discard-retention patterns described above again noted, and analyses of discards data from Scottish fisheries also presented (ICES, 2017).

21.3.3 Quality of catch data

Landings data have historically been of poor quality, as much of the landings data have been reported under generic landings categories. Most nations have made efforts to improve the recording of species in recent years.

Some northern European nations report more *M. mustelus* than *M. asterias* in official statistics, but WGEF combine these data, as *M. asterias* is the predominant and possibly the only species to occur around the British Isles.

Mustelus spp. are often taken in inshore fisheries, and landings data for vessels <10 m may not be complete.

M. asterias may be landed for bait in pot fisheries around the British Isles targeting whelk, and it is unclear whether such landings are reported consistently.

The availability of landings data from outside the ICES area (e.g. Mediterranean Sea) is limited, and the quality uncertain. In 2010, the European Commission collated landings data as an average across 2008–2010 and three species of *Mustelus* were represented in these data; *M. punctulatus* (269 t from Italy), *M. mustelus* (14 t combined from Italy, Spain, Malta and Slovenia) and *M. asterias* (1 t from Malta) (ICES, 2012). WGEF has not yet considered potential catches/landings for waters off NW Africa.

Better estimates of discarding are required, with information on discard survival also needed as a proportion of discarded *Mustelus* may survive.

21.3.4 Discard survival

Discard survival is variable across this family (Ellis *et al*., 2014 WD). Whilst quantitative data are limited in European waters, Fennessy (1994) reported at-vessel mortality of 29% for Arabian smooth-hound *Mustelus mosis* taken in a prawn trawl fishery. Mortality ranged from 57–93% for three triakid sharks taken in an Australian gillnet fishery, despite the soak times being <24 hours (Braccini *et al*., 2012). High survival of triakids has been reported in longline fisheries (Frick *et al*., 2010a; Coelho *et al*., 2012).

A UK research programme examining movements, behaviour and discard survival through electronic tagging of *M. asterias* found that in terms of at-vessel mortality, the longline fleet had the greatest proportion of fish in a lively condition (91%; primarily large individuals due to the selectivity of the gear), whilst gillnets had the highest mortality (56%) of the gears studied (McCully Phillips *et al*., 2019). Smaller individuals, which were caught mostly in beam trawls, were found to generally be in a poor condition (McCully Phillips *et al*., 2019).

21.4 Commercial catch composition

Studies to better understand the composition by size and sex (and species where there is spatial overlap) are required. Given the potential for sexual and sex-based segregation of *Mustelus*, as evidenced by sex-based dispersal of tagged fish (Griffiths *et al*., 2020), appropriate levels of monitoring would be required to fully understand catch composition over appropriate spatial and temporal scales.

21.4.1 Length composition of landings

In a UK study, 504 *M. asterias* samples (266 females; 238 males, Figure 21.3) were examined (McCully Phillips and Ellis, 2015), of which 286 (with a length range of 52–124 cm L_T) were landed by commercial vessels.

21.4.2 Length composition of discards

Silva and Ellis (2019) analysed the discard and retention patterns of *M. asterias* taken as bycatch in UK fisheries. Beam trawlers caught proportionally more juveniles (most records were of specimens of *ca.* 35–70 cm L_T), and discarding rates were high (95–99%). High rates of discarding (of smaller fish, <60 cm L_T) were also apparent in otter trawls, where about 63–71% of the total catches were discarded in the North Sea and Celtic Seas, respectively. Gillnets were more selective for larger fish (most fish were 60–100 cm L_T), and typically only larger fish (>70 cm L_T) were retained.

21.4.3 Sex ratio of landings

Of 286 commercially landed samples of *M. asterias* from the southern North Sea and eastern English Channel in May–November, 155 were female and 131 were male (McCully Phillips, unpublished). Due to *M. asterias* aggregating by sex and size, the sex ratio (and length–frequency) may vary over the year and between areas.

21.4.4 Quality of data

Mustelus length measurements may be collected as part of the concurrent sampling of the DCF. These data should be made available for future analysis.

21.5 Commercial catch and effort data

There are no data available.

21.6 Fishery-independent information

21.6.1 Availability of survey data

Several fishery-independent surveys operate in the stock area. They are often caught in GOV trawl and other otter trawl surveys in the area (Figure 21.4). For further details of trawl surveys in the stock area, see Section 15 (North Sea ecoregion), Section 18 (Celtic Seas) and Section 19 (Biscay-Iberia).

Larger individuals are not sampled effectively in beam-trawl surveys (because of low gear selectivity). For example, the UK western English Channel beam-trawl survey only occasionally records *M. asterias* >100 cm L_T (Silva *et al.*, 2020 WD; Figure 21.5).

Analyses of survey data need to be undertaken with care, as smooth-hounds are relatively large-bodied (the maximum size of *M. asterias* is at least 124 cm (McCully-Phillips and Ellis, 2015), with other sources suggesting they may attain 133 or 140 cm L_T) and adults may be strong swimmers, and able to avoid capture. As the largest individuals may not be sampled effectively in some survey gears, survey data may not sample the full length range effectively.

Given their aggregating nature, some surveys may have a large number of zero hauls and a few hauls with relatively large numbers, although this issue does not appear to be as pronounced as seen in spurdog.

Although two species of smooth-hound are often reported in surveys, the discrimination of these species was usually based on the presence or absence of spots, which is not a reliable characteristic. WGEF consider that survey data for these two species should be combined in any analyses, and that starry smooth-hound *M. asterias* is likely to be the only, or main, species in the Celtic Seas and North Sea ecoregions.

More detailed investigations of data in DATRAS undertaken by WGEF in 2017 indicate that data for *Mustelus* spp. and *Galeorhinus galeus* may have been confounded, with this most evident for Danish survey data (see Section 21.6.3), and so further analyses on the quality of IBTS-Q1 and IBTS-Q3 data could usefully be undertaken.

21.6.2 Survey trends

Updated survey data were examined by WGEF in 2021, as summarised below (see Section 21.9 for additional quantitative information).

IBTS-Q1 and IBTS-Q3

The IBTS surveys of the North Sea, undertaken in Q1 and Q3 by seven and six countries respectively, have a common time period of 30 years (1991–2020), and were included in the 2021 assessment. Both these surveys catch relatively low numbers of *M. asterias*, which may relate to smooth-hounds being more abundant in the more southern parts of the survey area. The long-term trend in abundance of smooth-hounds has increased over both the Q1 and Q3 time-series (Figure 21.6). The survey trends were updated in 2021 for the whole time series and will be averaged and treated as one following WKSKATE recommendation similarly to the skate stocks within the North Sea ecoregion (ICES, 2021b). Data presented for these surveys include all national data for Q1 and Q3 available on DATRAS, with the exception of Danish data for Q3 time-series as per issues described in Section 21.6.3.

EVHOE-WIBTS-Q4

This survey of ICES divisions 7.g–k and 8.a.b.d has a 23-year time-series of data (1997–2016, 2018–2020), and this survey was included in the assessment in 2021 (see Section 21.9), as it covers the south-western part of the stock area. Catch rates, though showing marked inter-annual variability, indicate a broadly increasing trend over the longer-term (Figure 21.7). The survey trends were updated for the whole time series in 2021, values may differ from previous results used in 2019 assessment as the new estimates used data available on DATRAS following methodology presented at WKSKATE (ICES, 2021b).

CGFS-Q4

This survey of ICES Division 7.d has a 24-year time-series of data (1997–2020), and this was included in the assessment in 2021 (see Section 21.9), as it covers part of the stock area in the eastern English Channel. Catch rates, though showing marked inter-annual variability, indicate a broadly increasing trend over the longer-term (Figure 21.7). Data considered for these estimations were based on data available on DATRAS, with calculations following methodology presented at WKSKATE (ICES, 2021b). This survey did not cover part of the survey grid in 2020 (ICES rectangles 29F1 and 30E9), however, data for 2020 were evaluated to better understand the potential impact in the assessment of this stock (see Section 21.9).

IGFS-WIBTS-Q4

This survey of ICES divisions 6.a and 7.b.g.j has a 16-year time-series of data (2005–2020), and this was included in the assessment in 2021 (see Section 21.9), as it covers the north-western part of the stock area. The increasing long-term trend in *M. asterias* is also evident in the Irish Groundfish Survey, although catch rates are generally low and more variable in recent years (2017–2020, Figure 21.10). This survey was previously used only as supporting information as it covers a shorter time-period in comparison to other surveys. However, following WKSKATE recommendations to increase the spatial coverage of the stock size indicator where deemed appropriated, further analyses were undertaken to include this survey in the assessment.

BTS-UK(E&W)-Q3 (in 7.afg[1])

This survey of ICES divisions 7.a and 7.f.g has a 28-year time-series of data (1993–2020), and catches reasonable numbers of *M. asterias*, albeit mostly immature specimens. This survey was not used in the 2021 assessment as the latter used survey indices of the exploitable biomass (individuals ≥ 50 cm L_T). The mean catch rate was derived from the catch rates from fixed stations (97 stations fished at least 24 years out of the 28-year time-series; Silva and Ellis, 2021 WD10). The temporal trend in CPUE (abundance and biomass for all individuals) indicate an increasing trend over the longer time series, though data indicate a decrease in 2018–2019. Both abundance and estimated biomass showed similar trends (Figure 21.9). Data are shown for 2020, however, these are considered not to be representative since these relate only to part of the survey area where this species is most abundant (ICES Division 7.f), and data for other parts of the survey area (where lower catches and more 'nil hauls' would be expected) are lacking (Silva and Ellis, 2021 WD10). The reduction in survey coverage in 2020 to only locations within ICES Division 7.f was due to the COVID-19 pandemic, with a total of 65 fixed stations used in the calculations in ICES Division 7.a and 7.g missed. While *M. asterias* is more commonly found in the Bristol Channel (7.f), there has been an increase in occurrence in the Irish Sea (7.a) in recent years compared to the early years of the time-series (Silva and Ellis, 2021 WD10).

BTS-Eng-Q3 (in 7.d and 4.c)

This survey of ICES divisions 7.d and 4.c has a 28-year time-series of data (1993–2020) and catches mostly juvenile *M. asterias*. It was not used in the 2021 assessment as the latter used survey indices of the exploitable biomass (individuals ≥50 cm L_T). The mean catch rate was derived from the catch rates from fixed stations (78 stations, Silva and Ellis, 2020b WD). The temporal trend in CPUE (abundance and biomass for all individuals) indicate an increasing trend over the longer time series, although CPUE is lower and more variable than recorded in the beam trawl survey of the Irish Sea and Bristol Channel (Figure 21.9). Survey indices for the whole time series were updated following on recommendations from WKSKATE (ICES, 2021b).

[1] Only one fixed (prime) station is within ICES Division 7.g (Prime 501). Also referred as UK(E&W)–BTS–Q3.

UK-Q1SWBEAM[2]

The UK beam-trawl survey in the western English Channel (7.e: 2006–2013), and more recently extended to cover the Celtic Sea (2014–2019) also encounters *M. asterias* (Figure 21.8). Analyses of these data (for the period 2006–2019) noted that 1098 specimens had been caught (713 ≥50 cm L_T for exploitable biomass calculations) accounting for 5% of the elasmobranch catch by numbers; the observed length range was 26–117 cm L_T (Silva *et al*., 2020 WD; Figure 21.5). In the western Channel (Division 7.e), the estimated total abundance and biomass showed similar trends, when considering all specimens and just fish of exploitable size, with peaks in 2009 and 2013–2014, and after a decrease in 2016, data suggest another abundance increase in 2018–2019 (Figure 21.8; Silva *et al*., 2020 WD). These results should be viewed as 'qualitative assessments', with further quantitative evaluations needed to better understand the utility of these trends for providing quantitative assessments and advice (Silva *et al*., 2020 WD).

Other surveys also capture *M. asterias.* Previous analyses of the UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea indicated increasing catch rates, but recent data have not been analysed.

Although smooth-hounds are not usually subject to additional biological sampling in trawl surveys, UK (England and Wales) and IGFS surveys tag and release *M. asterias*, and the individual weights and sex (all fish) and maturity (male fish only) are recorded prior to release (See Section 21.7.5).

21.6.3 Data quality

Exploratory analyses of DATRAS data (numbers at length data, 1992–2017) indicated that there may be some confounding data for *Mustelus* and *Galeorhinus*, which could be due to taxonomic errors or coding errors.

Exploratory data checks indicated the minimum and maximum recorded sizes of *Mustelus* spp. in IBTS-Q1 were 24–129 cm L_T (1992–2017). While the record of 129 cm L_T is to a certain degree questionable, it is also potentially valid, given the range in the reported L_{max} for the species. All nations recorded a minimum size of free-living pups that was greater than the length of the smallest neonates recorded by McCully Phillips and Ellis (2015), and so are within the accepted range.

Exploratory data checks indicated the minimum and maximum recorded sizes of *Mustelus* spp. in IBTS-Q3 were 22–149 cm L_T (1992–2016). Once again, the minimum lengths observed by each nation (22–70 cm L_T) were all within acceptable limits. During 1992–2016 in IBTS-Q3 most nations caught *Mustelus* spp. to a maximum length of 97–110 cm L_T, with one vessel (DAN) recording specimens larger than 110 cm L_T, and to 149 cm L_T.

For IBTS-Q3, the length-distributions available for *Mustelus* on DATRAS during 1992–2016 indicate that only one vessel (DAN) reports *Mustelus* spp. >110 cm L_T (Figure 21.11), and further explorations of DATRAS data indicate that there seems to be inter-annual variation in the species of triakid sharks caught (for specimens >110 cm L_T; Figure 21.12). These preliminary analyses suggest that DATRAS data for *Mustelus* and *Galeorhinus* are confounded for DAN, and further analyses of these data are required, in order to determine whether it is a coding error or misidentification, and also to determine the extent of this issue.

[2] This survey may also be referred to as 'Q1SWECOS', 'Q1SWBEAM ', 'BTS-UK-Q1' in other ICES-related documents.

For stock assessment purposes in 2021, the IBTS-Q1 and IBTS-Q3 indices were both based on data held on DATRAS and, although IBTS-Q1 included data from all countries, IBTS-Q3 included data from all countries except Danish data.

Further analyses of the quality of DATRAS data indicate that there are also some relatively large catches, with most large catch events related to a single vessel. Further analyses of these data are also required.

The indices used in the assessment for EVHOE-WIBTS-Q4 in 2021 were calculated using data currently available on DATRAS whereas in 2019, these were calculated using data held in the national database. The main differences between the two datasets relate to 2009 and 2010, as data currently on DATRAS show no *Mustelus* caught contrary to the national database. However, this will not affect the ratio of the mean of the last two values (index A) and the mean of the five preceding values (index B) used in the assessment.

Although discussions during WKSKATE highlighted the importance of using DATRAS datasets instead of national databases, there are remaining discrepancies in species mapping on historical data within BTS-UK(E&W)-Q3 (in 7.afg) survey series on DATRAS (e.g. *Scyliorhinus stellaris*). Therefore, to make calculations similar across sharks and skate species (with the latter shown in Silva and Ellis, 2020a WD), survey indices here presented relate to national data (Silva and Ellis, 2021 WD10).

The indices used in 2017 for BTS-Eng-Q3 (in 7.d and 4.c) were calculated using the ICES DATRAS data product *CPUE per length per Hour and Swept Area*. During the WGEF meeting in 2019, an error was found within the DATRAS data product thus, survey indices in 2019 were calculated using data held in the national database (see Section 21.6 in ICES, 2020). In 2021, these indices were recalculated using DATRAS exchange data and presented at WKSKATE (ICES, 2021b). Although discrepancies between data held within DATRAS and national database may remain, recommendations from WKSKATE were followed and indices provided to WGEF 2021 used a selection of fixed (prime) stations within DATRAS exchange data. The stations chosen for the indices calculations were the same as if using data held within national database (Silva and Ellis, 2020b WD; ICES, 2021b).

21.7 Life-history information

Biological data are not collected under EU-MAP, although some *ad hoc* data are collected on fishery-independent surveys and there are some published studies resulting from biological investigations of *Mustelus* spp. in European seas, including from the NE Atlantic and Mediterranean Sea.

21.7.1 Habitat

The distribution of *Mustelus asterias* around the British Isles has been described, with more detailed studies on the habitat utilization undertaken for the eastern English Channel (Martin *et al.*, 2010; 2012).

21.7.2 Spawning, parturition and nursery grounds

Mustelus asterias pups are taken in trawl surveys (including beam trawl surveys), and such data might be able to assist in the preliminary identification of pupping and primary nursery grounds. Most of the records for *M. asterias* pups recorded in UK beam-trawl surveys are from the southern North Sea, English Channel (including near the Solent) and Bristol Channel (Ellis *et al.*, 2005).

Studies on other species of smooth-hound have shown high site fidelity of immature individuals on nursery grounds (Espinoza *et al*., 2011).

Recent biological studies have indicated that full-term pups of *M. asterias* range in size from 205–329 mm L_T and pup size was positively correlated with maternal length (McCully Phillips and Ellis, 2015; Figure 21.13). The smallest free-swimming neonate reported by this study was 24 cm L_T.

Parturition of *M. asterias* occurred in February in the western English Channel and June–July in the eastern English Channel and southern North Sea (Figure 21.14), indicating either protracted spawning or asynchronous parturition for the stock (McCully Phillips and Ellis, 2015).

21.7.3 Age and growth

Mustelus asterias

Farrell *et al*. (2010a) studied the age and growth in the Celtic Seas ecoregion. Growth parameters for males (n = 106) were L_∞ = 103.7 cm L_T, L_0 = 38.1 cm, k = 0.195 year^{-1}). Growth parameters for females (n = 114) were (L_∞ = 123.5 cm L_T, L_0 = 34.9 cm, k = 0.146 year^{-1}). Estimates of longevity were 13 years (males) and 18.3 years (females). The lengths-at-age for *M. asterias* based on these growth parameters are given in Table 21.3.

An analysis of samples collected in waters around the British Isles between 2009–2019 provides preliminary estimates of L_∞ = 94.6 cm for males (n = 159, L_T = 24–100 cm ages 0–14) and L_∞ = 130.1 cm females (n = 163, L_T = 28–124 cm ages 0–17) (Ellis *et al.*, 2019 WD), although it should be noted that this study had more fish at age 0. Further work is required to evaluate the estimated ages and, in terms of stock assessment modelling, the results of Farrell *et al.* (2010a) should still be used at the present time.

Mustelus mustelus

Age and growth have been reported for South African waters, with males and females estimated to mature at 6–9 and 12–15 years, respectively (Goosen and Smale, 1997). The maximum age reported in this study was 24 years.

21.7.4 Reproductive biology

Mustelus asterias

Studies in the Celtic Seas ecoregion indicated that the total length (and age) at 50% maturity for male and females are 78 cm L_T (4–5 years) and 87 cm L_T (six years), respectively (Farrell *et al.*, 2010b). A subsequent study, collected primarily from the southern North Sea and English Channel, estimated 50% maturity for males at 70.4 cm L_T (smallest mature = 65 cm; largest immature = 74 cm) and females at 81.9 cm L_T (smallest mature = 69 cm; largest immature = 87 cm) (McCully Phillips and Ellis, 2015; Figure 21.15). A recent analysis of samples collected between 2009–2019 by fishery-independent trawl surveys conducted by Cefas in waters around the British Isles estimated 50% maturity for males at 73.5 cm L_T (smallest mature = 64 cm; largest immature = 99 cm), with 100% maturity attained at ca. 90 cm, and females at 85.4 cm L_T (smallest mature = 75 cm; largest immature = 91 cm), with 100% maturity attained at ca. 92 cm (Ellis *et al.*, 2019 WD).

The smallest mature female that Farrell *et al*. (2010b) reported was 83 cm; considerably larger than the smallest females (69 cm and 75 cm L_T; summarised above) recorded by McCully Phillips and Ellis (2015) and Ellis *et al.* (2019 WD). This is interesting, as the studies use slightly different maturity keys, with Farrell *et al*. (2010b) assigning a female to be mature when oocytes were present, yellow, and countable at >3 mm in diameter, whereas the Cefas maturity keys (Table II of McCully Phillips and Ellis, 2015), which are comparable to those keys developed within ICES, assigned a female as mature when the oocytes are slightly larger (>5 mm).

Estimates of fecundity range from 8–27 (ovarian fecundity) and 6–18 (embryonic fecundity), with a gestation period of about twelve months (Farrell *et al*., 2010b), and there may also be a resting period of a year between pregnancies, giving a two-year reproductive period. Mature female specimens sampled by McCully Phillips and Ellis (2015) included seventeen late gravid females with term pups (uterine fecundity 4–20), which were found to have numerous yolk-filled follicles (n = 6–22; follicle diameters 6–10 mm). Further studies, including more samples of fish from winter and spring, are required to better gauge the reproductive period.

The number of mature follicles ranged from 0–28 in the mature females (McCully Phillips and Ellis, 2015). These will not all necessarily develop into embryos, however, and estimates of ovarian fecundity are known to exceed estimates of uterine fecundity. The size-spectra of the mature follicles (within mature females) ranged from 4.1 mm (mid-term gravid female) to 20.7 mm (mature female).

The uterine fecundity increased with total length and ranged from 4–20 (McCully Phillips and Ellis, 2015), which exceeded the maximum uterine fecundity (18) found by Farrell *et al*. (2010b), although they stated that their values may be underestimated due to females aborting pups on capture. The female identified with a fecundity of 20, was found with full-term pups. Furthermore, there were also positive linear relationships identified between maternal length and average pup length and weight (Figure 21.13; McCully Phillips and Ellis, 2015).

A combined dataset on uterine fecundity, using data from Henderson *et al.* (2003), Farrell *et al.* (2010b), McCully Phillips and Ellis (2015) and additional samples collected during fishery-independent trawl surveys conducted by Cefas is given in Table 21.4 (Ellis *et al*., 2019). Of the 74 early- to late-gravid females in this combined study, the uterine fecundity ranged from 2–20 (mean = 8.5) which is similar to the initial studies of subsets of this combined dataset (summarised above). Uterine fecundity (F) had a linear relationship with L_T, as described by the equation $F = 0.28390.L_T - 19.18583$ ($n = 74$; $r^2 = 0.4295$; Figure 21.16).

In the Mediterranean Sea, *Mustelus asterias* reach maturity at about 75 cm (males) and 96 cm (females), with estimates of fecundity ranging from 10–45 (ovarian fecundity) and 10–35 (uterine fecundity), with fecundity increasing with length (Capapé, 1983), although it is possible the higher fecundity in this study may relate to data being confounded with other species of smooth-hound.

Mustelus mustelus

Studies in the Mediterranean Sea have found that females matured at 107.5–123 cm L_T (50% maturity at 117.2 cm) and that males matured at 88–112 cm L_T (50% maturity at 97.1 cm) (Saidi *et al*., 2008). This study also found that embryonic fecundity ranged from 4–18 embryos, with fecundity increasing with length. Further south off Senegal, the lengths at first (and 100%) maturity for *M. mustelus* were found to be 82 cm (95 cm), for males, and 95 cm (104 cm) for females (Capapé *et al*., 2006). This study reported litters of 4–21 pups.

21.7.5 Movements and migrations

Mustelus asterias

Although the movements and migrations of *M. asterias* are not fully known, there have been relatively high numbers tagged and released during various elasmobranch research programmes (e.g. Burt *et al*., 2013 WD, Ellis *et al*., 2019 WD). A tagging programme (2011–2014) undertaken by Sportvisserij Nederland, in conjunction with Wageningen Marine Research, involved anglers tagging *M. asterias* in the Dutch Delta. There were 2244 releases, of which 80 recaptures were reported (Figure 21.18; Brevé *et al*., 2016). Recapture positions indicated annual migrations between summertime grounds in the southern North Sea and overwintering in the English Channel and Bay of Biscay, suggesting a degree of philopatry (Brevé *et al*., 2016). This is an on-going tagging programme, and more recently Brevé *et al*. (2020) reported that during 2011–2019 a total of 3699 starry smooth-hounds were released, of which 220 recaptures were reported (ca. 5.9% return rate). The recent results support previous work from Brevé *et al*. (2016).

Cefas have tagged-and-released specimens of *M. asterias* from fishery-independent trawl surveys since 2003 (Burt *et al*., 2013). In 2019, a total of 1613 (744 females and 868 males, one unsexed) had been tagged and released, of which 40 (2.48%) have been recaptured and details returned (Ellis *et al*., 2019 WD). Results suggest that the species is wide ranging in northern European seas and displays seasonal migrations, which are likely related to its reproductive cycle (Figure 21.17; Ellis *et al*., 2019 WD). An electronic tagging programmes initiated by Cefas in 2017–2019 deployed 125 tags with a return rate of 14.4% to date. On a broad-scale, sex-biased dispersal and potential metapopulation-like stock structuring either side of the UK continental shelf was seen along with a clear diel variation in vertical activity and association with the seabed at the finer-scale (Griffiths *et al*., 2020).

21.7.6 Diet and role in ecosystem

Mustelus asterias is primarily carcinophagous (98.8% percentage of index of relative importance, %IRI), with the two main prey species being hermit crab *Pagurus bernhardus* (34% IRI) and flying crab *Liocarcinus holsatus* (15% IRI) in specimens from the Northeast Atlantic (McCully Phillips, *et al*., 2020). Ontogenetic dietary preferences showed that smaller individuals [20–69 cm total length (L_T)] had a significantly lower diversity of prey than larger individuals (70–124 cm L_T) and similarly, specimens from the North Sea ecoregion had a lower diversity of prey types for a given sample size than fish from the Celtic Seas ecoregion (McCully Phillips, *et al*., 2020). This study did not find any fish remains in the examination of 640 stomachs, however Ford (1921) and Ellis *et al*., (1996) found that teleosts were only eaten occasionally by larger individuals. Larger individuals can be important predators of commercial crustaceans, feeding on velvet swimming crab *Necora puber* and small edible crab *Cancer pagurus* (McCully Phillips, *et al*., 2020).

Other studies on the feeding habits of *Mustelus* also indicate a high proportion of crustaceans in the diet (Morte *et al*., 1997; Jardas *et al*., 2007; Santic *et al*., 2007; Saidi *et al*., 2009; Lipej *et al*., 2011).

The trophic level of specimens from the Northeast Atlantic was calculated as 4.34 when species-level prey categories were used; a value higher than previously indicated by other studies (Cortés, (1999; 3.7), Cotter *et al*. (2008; 3.9), and Pinnegar *et al*. (2002; 4.0)) due to the high tropic levels of their preferred crustacean prey species (McCully Phillips, *et al*., 2020). This will have ramifications for food web and ecosystem modelling, with the role of this species potentially underestimated to date.

21.7.7 Conversion factors

The relationship between total length and weight in the smooth-hounds sampled by McCully Phillips and Ellis (2015) are summarised below by sex and maturity stage (see also figures 21.20 and 21.21).

The relationship for males differed slightly to that of females, largely driven by the larger maximum length of females and the weights of females about to give birth. Of note is the 119 cm outlier, which was a post-partum female with a very low body mass. Samples of the smaller size classes were obtained from scientific trawl surveys, while the larger individuals were commercially-landed specimens.

Relationship Y = ax^b	Sex/Stage	a	b	r^2	n
Total weight to total length	All females	0.0014	3.2	0.992	248
	All males	0.0020	3.1	0.995	237
	Immature female (stage A/B)	0.0020	3.1245	0.994	170
	Immature male (stage A/B)	0.0014	3.2159	0.991	113
	Mature female (including early gravid) (stage C/D)	0.0021	3.1396	0.913	54
	Mature male (stage C/D)	0.0077	2.8084	0.938	123
	Mid-/late-term gravid females (stage E/F)	0.0002	3.7072	0.935	21
Gutted weight to total length	Sexes combined	0.0014	3.1580	0.995	484
	Female	0.0016	3.1	0.994	249
	Male	0.0014	3.2	0.996	235

Recent data on overall length-weight relationships for male and female *M. asterias* caught between 2009–2019 by Cefas fishery-independent trawl surveys around the British Isles are illustrated in Figure 21.19.

21.8 Exploratory assessment models

21.8.1 Previous studies

No previous assessments of NE Atlantic smooth-hounds have been made. However, there have been assessment methods developed for the Australian species *Mustelus antarcticus* (e.g. Xiao and Walker, 2000; Pribac *et al.*, 2005) which may be applied to European species when relevant data are available.

21.8.2 Data exploration and preliminary assessments

An analytical age-, sex-, and length-structured assessment model was explored for *M. asterias* following the approach of De Oliveira *et al.* (2013) for spurdog, however, further work is required.

21.9 Stock assessment

No quantitative stock assessment is available yet.

Since 2015, the stock of *M. asterias* in northern Europe was evaluated using trends from fishery-independent trawl surveys, as these are the longest time-series of standardised species-specific data available.

The biomass trends of the long-term time-series of three different surveys covering a proportion of the species distribution range were used in the 2019 assessment (IBTS-Q1, IBTS-Q3 and EVHOE-WIBTS-Q4). Following WKSKATE recommendation to investigate the expansion of the spatial coverage of Category 3 stock size indicators where considered appropriate (ICES, 2021b), further investigations were conducted during WGEF on the data available for *Mustelus* spp. from two additional GOV surveys (IGFS-WIBTS-Q4 and CGFS-Q4). These surveys were considered more effective at sampling larger specimens than beam trawl surveys (see below).

IBTS-Q1 and IBTS-Q3

Data from the two North Sea IBTS were used (see Section 15 for further details). These surveys sample the more northerly parts of the stock area. The biomass index of specimens ≥50 cm L_T of *Mustelus* spp. was used, though the GOV samples mostly larger fish (Figure 21.6). Data from Denmark were excluded in analyses for the IBTS-Q3, due to the suspicion that data for *Mustelus* and *Galeorhinus* were confounded (see Section 21.6.3). The temporal trends in abundance, total biomass and exploitable biomass (specimens ≥50 cm L_T) all showed similar patterns (Figure 21.6).

EVHOE-WIBTS-Q4

A biomass index of specimens ≥50 cm L_T of *Mustelus* spp. from the EVHOE-IBTS-Q4, was included in 2021, as this survey covers more south-western parts of the stock area (divisions 8.a.b.d; Figure 21.7). Data were available for 1997–2020 (excluding 2017) and indicate an increasing total and exploitable biomass. The total biomass was calculated using the weight from on-board catch weight per species, as no individual weight is available for most of the years. Exploitable biomass (specimens >50 cm L_T) was calculated using the length-weight relationship with $W_T = 0.0016 \cdot L_T^{3.1753}$.

CGFS-Q4

A biomass index of specimens ≥50 cm L_T of *Mustelus* spp. from the CGFS-Q4, was included in 2021, as this survey covers the eastern English Channel part of the stock area (Division 7.d; Figure 21.7). Data were available for 1997–2020 and indicate an increasing total and exploitable biomass. However, in 2020 the survey did not cover part of the survey grid (ICES rectangles 29F1 and 30E9). Consequently, four scenarios were run to evaluate the overall impact on the stock size indicator:

1. CGFS-Q4 time series excluded;
2. CGFS-Q4 included for the whole time series (1997–2020) and all available survey data;
3. CGFS-Q4 included for 1997–2019 with 2020 data excluded;
4. CGFS-Q4 included for the whole time series (1997–2020) excluding data from survey stations in ICES rectangles 29F1 and 30E9.

Results show that in all four scenarios there would be an increase in the stock size indicator. However, if excluding the CGFS-Q4 time series (scenario 1) the increase would be less pronounced comparatively to the other three scenarios (Table 21.6). The remaining scenarios show negligible impact on the overall stock size indicator thus, the EG agreed to use all data available for this survey time-series in the assessment (Table 21.6, Figure 21.25).

IGFS-WIBTS-Q4

Although the inclusion of this survey reduces the common time frame from 1997–2020 to 2005–2020, it covers the north-western parts of the stock area (divisions 6.a and 7.b.g.j) hence, was used in 2021 assessment. The biomass index of specimens ≥50 cm L_T of *Mustelus* spp. was used, though the GOV samples mostly larger fish (Figure 21.6). Data were available for 2005–2020 and indicate an increasing total and exploitable biomass, though more variable in recent years (Figure 21.10).

BTS-UK (E&W)-Q3 and BTS-Eng-Q3

These surveys sample juvenile *M. asterias* primarily, and so in 2021 were excluded from the assessment and advice. Data from 1993–2016 indicate that the abundance of pups has increased over the time series in the Irish Sea/Bristol Channel (BTS-UK(E&W)-Q3), but has been more stable in the eastern English Channel and southern North Sea (BTS-Eng-Q3) (Figure 21.23). Further analyses of these data are required, as it may be possible to develop an index of recruitment from such surveys. Other beam trawl surveys could also benefit from further appraisal in terms of *Mustelus* occurrence, spatial distribution and length frequency distribution and their potential suitability to provide further information.

Summary

The stock size indicator is based on 'exploitable biomass' (individuals ≥50 cm total length). The inclusion of additional surveys such as the IGFS-WIBTS-Q4, truncates the common time period from 1997–2020 to 2005–2020, however, it does extend the range of spatial coverage in relation to the stock distribution. IBTS-Q1 and IBTS-Q3 were averaged prior to standardised in relation to the long-term mean for the common time period (2005–2020) and thus, treated as a single survey following recommendations from WKSKATE (ICES, 2021b). The remaining three survey indices were also standardised in relation to their long-term mean for the common time period (2005–2020). The average of the four surveys was used to derive an annual index of stock size. In 2017, EHVOE-WIBTS-Q4 did not occur and the average for the annual index of stock size was based on the other surveys. All four surveys were given equal weighting. The mean index for the years 2019–2020 was 1.76, whilst the mean index for the preceding five years (2014–2018) was 1.42, with the most recent 2-year period being 1.24 times that of the preceding 5-year period (Figure 21.22; Table 21.5). CGFS-Q4 in 2020 was included in 2021 assessment as reduction in the survey area has shown negligible impact on the index ratios (Table 21.6, Figure 21.25).

Further studies to better quantify differences between 'total biomass' and 'exploitable biomass' are still to be undertaken. Such work could usefully be appraised during a dedicated workshop for smooth-hounds *Mustelus* spp. and tope *Galeorhinus galeus* as recommended during WKSKATE (ICES, 2021b). Furthermore, the suitability of statistical modelling to provide a single survey index and associated confidence intervals, similar to work developed for spurdog during the benchmark in 2021 (ICES, 2021a), could usefully be examined for *Mustelus*. This would allow for the potential use of multiple surveys while accounting for potential differences (e.g. season, design, gear, depth, sex, length class).

21.10 Quality of the assessment

Commercial landings data are available for recent years but may be compromised by poor data quality. Whilst fishery-independent trawl surveys provide the best time-series information, such surveys may under-represent the largest size classes. It is unclear as to how recent increases in CPUE may relate to increased stock abundance and/or a possible northward shift in distribution.

The positions of survey hauls containing smooth-hounds in the EVHOE-WIBTS-Q4 survey were plotted over the 1997–2019 time-series (Figure 21.24). The number of stations catching smooth-hounds increased over the survey, but the distribution of the catches has remained constant, occurring north of 46°N. There was no evidence from this survey to support the theory of a northward shift in the distribution, which would support the suggestion that increasing catch rates reflect population growth.

21.11 Reference points

No reference points have been determined for this stock.

21.12 Conservation considerations

The most recent IUCN Red List Assessment for European marine fishes (Nieto *et al*., 2015) upgraded all three *Mustelus* spp. to either Near Threatened (*M. asterias*) or Vulnerable (*M. mustelus* and *M. punctulatus*), identifying them as of increasing conservation interest. These species were listed previously as either Data Deficient or Least Concern (Gibson *et al.,* 2008).

21.13 Management considerations

Smooth-hounds appear to be increasing in relative abundance in trawl surveys, and in commercial landings data. Given the potential expansion in fisheries for smooth-hounds (which may reflect an increased abundance and that fishing opportunities for *S. acanthias* are limited), further studies to understand the dynamics, distribution and geographic boundaries of this stock are required.

Smooth-hounds taken by beam trawl are primarily juveniles and subadults (<70 cm L_T), and these are often discarded, as are smooth-hounds <50 cm L_T in otter trawl fisheries. Discard survival has not been quantified for many metiers, and survival is variable in this family (Ellis *et al*., 2014 WD). Further studies on the at-vessel mortality and post-release mortality, including of juveniles, are needed.

Survey data are available, and the quality of landings data is thought to be improving. Whilst there have been several recent biological investigations (Farrell *et al*., 2010a, b; McCully Phillips and Ellis, 2015), there is still uncertainty in some key biological parameters, including the duration of the reproductive cycle.

Smooth-hounds are also an important target species in some areas for recreational fisheries; though there are insufficient data to examine the relative economic importance of these fisheries, or the degree of mortality associated with recreational fisheries.

Other species of smooth-hound are targeted elsewhere in the world, including Australia/New Zealand and South America. Although smooth-hounds are generally quite productive stocks (relative to some other elasmobranchs), evidence from these fisheries suggests that various management controls can be appropriate.

21.14 References

Braccini, M., Van Rijn, J., and Frick, L. 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS One*, 7(2), e32547, 1–9.

Brevé, N.W.P., Winter, H.V., Van Overzee, H.M.J., Farrell, E.D. and Walker, P.A. 2016. Seasonal migration of the starry smooth-hound shark *Mustelus asterias* as revealed from tag-recapture data of an angler-led tagging programme. *Journal of Fish Biology*, 89(2), 1158–1177.

Brevé, N.W.P., Winter, H.V., Wijmans, P.A.D.M., Greenway, E.S.I. and Nagelkerke, L.A.J. 2020. Sex differentiation in seasonal distribution of the starry smoothhound *Mustelus asterias*. *Journal of Fish Biology*, 97: 1870–1875. https://doi.org/10.1111/jfb.14548.

Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V.A. and Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document to the Working Group on Elasmobranch Fishes, Lisbon, Portugal, 17–21 June 2013. 12 pp.

Capapé, C. 1983. New data on the biological of the reproduction of *Mustelus asterias* Cloquet, 1821 (Pisces, Pleurotremata, Triakidae) from Tunisian coasts. *Vie et Milieu*, 33: 143–152.

Capapé, C., Diatta, Y., Diop, M., Vergne, Y. and Guelorget, O. 2006. Reproductive biology of the smoothhound, *Mustelus mustelus* (Chondrichthyes: Triakidae) from the coast of Senegal (eastern tropical Atlantic). *Cybium*, 30: 273–282.

Coelho, R., Fernandez-Carvalho, J., Lino, P.G., and Santos, M.N. 2012. An overview of the hooking mortality of elasmobranchs caught in a swordfish pelagic longline fishery in the Atlantic Ocean. *Aquatic Living Resources*, 25: 311–319.

Compagno, L., Dando, M. and Fowler, S. 2005. Sharks of the World. Collins Field Guide. Harper Collins Publishers, London.

Cortés, E. (1999). Standardized diet compositions and trophic levels of sharks. *ICES Journal of Marine Science*, 56: 707–717.

Cotter, J., Rogers, S., Ellis, J., Mackinson, S., Dulvy, N., Pinnegar, J., Jennings, S. and Greenstreet, S. (2008). Marine Ecosystem Integrity: Development of a Marine Trophic Index for UK waters and recommendations for further indicator development. Cefas contract report C3140. Final report for Natural Environment Group, Science Division, Defra, Bristol, UK (CRO 382).

De Oliveira, J. A. A., Ellis, J. R. and Dobby, H. 2013. Incorporating density dependence in pup production in a stock assessment of NE Atlantic spurdog *Squalus acanthias. ICES Journal of Marine Science*, 70: 1341–1353.

Ellis, J. R., Cruz-Martinez, A., Rackham, B. D. and Rogers, S. I. 2005. The distribution of chondrichthyan fishes around the British Isles and implications for conservation. *Journal of Northwest Atlantic Fishery Science*, 35: 195–213.

Ellis, J. R., Maia, C., Hampton, N., Eastley, G., Silva, J. F. and McCully Phillips, S. R. 2019. Updated biological parameters for starry smooth-hound *Mustelus asterias* in the North-east Atlantic. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, June 18–27 2019; 17 pp.

Ellis, J. R.., McCully, S. R. and Poisson, F. 2014. A global review of elasmobranch discard survival studies and implications in relation to the EU 'discard ban'. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, Portugal. June 2014. 48 pp.

Ellis, J. R., Pawson, M. G. and Shackley, S. E. 1996. The comparative feeding ecology of six species of shark and four species of ray (Elasmobranchii) in the North-East Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 76: 89–106.

Espinoza, M., Farrugia, T. J. and Lowe, C. G. 2011. Habitat use, movements and site fidelity of the gray smooth-hound shark (*Mustelus californicus* Gill, 1863) in a newly restored southern California estuary. *Journal of Experimental Marine Biology and Ecology*, 401: 63–74.

Farrell, E. D., Clarke, M. W. and Mariani, S. 2009. A simple genetic identification method for Northeast Atlantic smoothhound sharks (*Mustelus* spp.). *ICES Journal of Marine Science*, 66: 561–565.

Farrell, E. D., Mariani, S. and Clarke, M. W. 2010a. Age and growth estimates for the starry smoothhound (*Mustelus asterias*) in the Northeast Atlantic Ocean. *ICES Journal of Marine Science*, 67: 931–939.

Farrell, E. D., Mariani, S. and Clarke, M. W. 2010b. Reproductive biology of the starry smoothhound shark *Mustelus asterias*: Geographic variation and implications for sustainable exploitation. *Journal of Fish Biology*, 77: 1505–1525.

Fennessy, S. T. 1994. Incidental capture of elasmobranchs by commercial prawn trawlers in the Tugela Bank, Natal, South Africa. *South African Journal of Marine Science*, 14: 287–296

Ford, E. (1921). A contribution to our knowledge of the life-histories of the dogfishes landed at Plymouth. *Journal of the Marine Biological Association of the United Kingdom*, 12: 468–505.

Frick, L. H., Reina, R. D. and Walker, T. I. 2010. Stress related changes and post-release survival of Port Jackson sharks (*Heterodontus portusjacksoni)* and gummy sharks (*Mustelus anarcticus)* following gill-net and longline capture in captivity. *Journal of Experimental Marine Biology and Ecology*, 385: 29–37.

Gibson, C., Valenti, S.V., Fordham, S.V. and Fowler, S.L. 2008. The Conservation of Northeast Atlantic Chondrichthyans: Report of the IUCN Shark Specialist Group Northeast Atlantic Red List Workshop. viii + 76 pp.

Griffiths, C. A., Wright, S. R., Silva, J. F., Ellis, J. R., Righton, D. A. and McCully Phillips, S. R. 2020. Horizontal and vertical movements of starry-smooth hound *Mustelus asterias* in the Northeast Atlantic. *PLoS ONE*, 15 (10): e0239480. https://doi.org/10.1371/journal.pone.0239480.

Goosen, A. and Smale, M. J. 1997. A preliminary study of age and growth of the smoothhound shark *Mustelus mustelus* (Triakidae). *South African Journal of Marine Science*, 18: 85–91.

Henderson, A.C., Flannery, K. and Dunne, J. (2003). Biological observations on shark species taken in commercial fisheries to the west of Ireland. *Proceedings of the Royal Irish Academy*, 103B: 1–7.

ICES. 2012. Report of the 6th Meeting of the Mediterranean Planning Group for Methodological Development (PGMED). 30 January to 5 February, 2012, Rome.

ICES. 2016a. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40; 69 pp.

ICES. 2016b. First Interim Report of the International Bottom Trawl Survey Working Group (IBTSWG), 4–8 April 2016, Sète, France. ICES CM 2016/SSGIEOM:24; 292 pp.

ICES. 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20–24 February 2017, Nantes, France. ICES CM 2017/ ACOM:38; 119 pp.

ICES. 2020. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 2:77. 789 pp. http://doi.org/10.17895/ices.pub.7470.

ICES. 2021a. Benchmark Workshop on North Sea Stocks (WKNSEA). ICES Scientific Reports. 3:25. 756 pp. https://doi.org/10.17895/ices.pub.7922.

ICES. 2021b. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 183 pp. https://doi.org/10.17895/ices.pub.7948.

Jardas, I., Santic, M., Nerlovic, V. and Pallaoro, A. 2007. Diet of the smooth-hound, *Mustelus mustelus* (chondrichthyes: Triakidae), in the eastern Adriatic Sea. *Cybium*, 31: 459–464.

Lipej, L., Mavric, B., Resek, S., Chérif, M. and Capapé, C. 2011. Food and feeding habits of the blackspotted smooth-hound, *Mustelus punctulatus* (Elasmobranchii: Carcharhiniformes: Triakidae), from the northern Adriatic. *Acta Ichthyologica et Piscatoria*, 41: 171–177.

Martin C. S., Vaz, S., Ellis, J. R., Coppin, F., Le Roy, D. and Carpentier, A. 2010. Spatio-temporal patterns of demersal elasmobranchs in trawl surveys in the eastern English Channel (1988–2008). *Marine Ecology Progress Series*, 417: 211–228.

Martin, C. S., Vaz, S., Ellis, J. R., Lauria, V., Coppin, F. and Carpentier, A. 2012. Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment. *Journal of Experimental Marine Biology and Ecology*, 418/419: 91–103.

McCully, S and Ellis, J. R. 2014. Biological studies to inform management of smooth-hounds (*Mustelus* spp.) in the North-east Atlantic. Working Document to ICES Working Group on Elasmobranch Fishes. Lisbon, Portugal. 16 pp.

McCully Phillips, S.R. and Ellis, J.R., 2015. Reproductive characteristics and life-history relationships of starry smooth-hound *Mustelus asterias* in British waters. *Journal of Fish Biology*, 87: 1411–1433.

McCully Phillips, S.R., Grant, A. and Ellis, J.R., 2020. Diet composition of starry smooth-hound *Mustelus asterias* and methodological considerations for assessing the trophic level of predatory fish. *Journal of Fish Biology*, 96: 590–600.

McCully Phillips, S. R., Griffiths, C. A., Silva, J. F., Wright, S. and Ellis, J. R. (2019). Discard survival and movements of starry smooth-hound. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Final report, Contract C7246, x + 79 pp.

Morte, S., Redon, M. J. and Sanz-Brau, A. 1997. Feeding habits of juvenile *Mustelus mustelus* (Carcharhiniformes, Triakidae) in the western Mediterranean. *Cahiers de Biologie Marine*, 38: 103–107.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., Garcia Criado, M., *et al.* 2015. *European Red List of marine fishes*. Luxembourg: Publications Office of the European Union.

Pinnegar, J. K., Jennings, S., O'Brien, C. M. and Polunin, N. V. C. (2002). Long-term changes in the trophic level of the Celtic Sea fish community and fish market price distribution. *Journal of applied ecology*, 39: 377–390.

Pribac, F., Punt, A. E. Taylor, B. L. and Walker, T. I. 2005. Using length, age and tagging data in a stock assessment of a length selective fishery for gummy shark (*Mustelus antarcticus*). *Journal of Northwest Atlantic Fishery Science*, 35: 267–290.

Quignard, J. P. 1972. Note sur les especes mediterraneenes du genre *Mustelus* (Selachii, Galeoidea, Triakidae). *Rev. Trav. Inst. Peches Marit*., Nantes, 36(1): 15–29.

Saidi, B., Bradai, M. N. and Bouain, A. 2008. Reproductive biology of the smooth-hound shark *Mustelus mustelus* (L.) in the Gulf of Gabes (south-central Mediterranean Sea). *Journal of Fish Biology*, 72: 1343–1354.

Saidi, B., Enajjar, S., Bradai, M. N. and Bouain, A. 2009. Diet composition of smooth-hound shark, *Mustelus mustelus* (Linnaeus, 1758), in the Gulf of Gabes, southern Tunisia. *Journal of Applied Ichthyology*, 25: 113–118.

Santic, M., Nerlovic, V. and Pallaoro, A. 2007. Diet composition of blackspotted smooth-hound, *Mustelus punctulatus* (Risso, 1826), in the eastern Adriatic Sea. *Journal of Applied ichthyology*, 23: 279–281.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980. https://doi.org/10.1111/jfb.13899.

Silva, J. F., Ellis, J. R. and Kupschus, S. 2020. Demersal elasmobranchs in the western Channel (ICES Division 7.e) and Celtic Sea (ICES Divisions 7.f-j). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), June 16–25 2020.

Silva, J.F. and Ellis, J. R. 2020a. Skates in the UK beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), June 16–25 2020, 6 pp.

Silva, J. F. and Ellis, J. R. 2020b. Skates caught in the Q3 English beam trawl survey of the eastern English Channel (ICES Division 7.d) and southern North Sea (ICES Division 4.c). Working Document to the ICES Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE), 23rd–27th November 2020, 16 pp.

Silva, J. F. and Ellis, J. R. 2021. Catsharks and smooth-hounds in the UK (E&W) beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g). Working Document to the ICES Working Group on Elasmobranch Fishes, June 15-June 24, 2021; 12 pp.

Xiao, Y. and Walker, T. I. 2000. Demographic analysis of gummy shark (*Mustelus antarcticus*) and school shark (*Galeorhinus galeus*) off southern Australia by applying a generalized Lotka equation and its dual equation. *Canadian Journal of Fisheries and Aquatic Sciences*, 57: 214–222.

Table 21.1. Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (t) for the period 1973–2014. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for the north-west African waters. Data from 2005 are lower than reported to ICES (2016a) and are considered underestimates (see Table 21.2 for recent estimates of landings 2005–2016).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	
France	0	0	0	0	0	0	32	0	0	222	218	66	143	167
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	-
Portugal	.	.	.	.	.	.	.	.	.	.	.	.		-
UK -E, W & NI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	32	0	0	222	218	66	143	167

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium													
France	119	64	117	126	93	90	102	138	145	228	187	197	0
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	
Portugal													
UK -E, W & NI	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	0	0
	119	64	117	126	93	90	102	138	145	228	187	197	0

Table 21.1. (continued). Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (t) for the period 1973–2014. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for the north-west African waters. Data from 2005 are lower than reported to ICES (2016a) and are considered underestimates (see Table 21.2 for recent estimates of landings 2005–2016).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	8	10	1
France	306	377	585	589	682	767	714	908	522	926	969	706	2695	2955	2825
Netherlands	.	.	.	.	.	.	.	.	.	.	8	3	11	20	15
Portugal	.	.	.	.	.	.	.	.	.	.	.	35	42	41	187
Spain	.	.	.	.	.	.	.	.	.	.	34	48	9	83	14
UK -E, W & NI	14	0	0	0	0	0	0	0	115	132	161	919	337	323	647
UK - Scotland	0	0	0	0	0	0	0	0	0	1	0	-	-	-	-
	320	377	585	589	682	767	714	908	637	1059	1172	1712	3101	3433	3690

Table 21.2 Smooth-hounds in the Northeast Atlantic. ICES estimated landings (t; 2005–2020), based on data provided in the ICES Data Call (see ICES, 2016a). Blank = no data reported; 0 < 0.5 tonnes. Data revised in 2021.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium									1	1	1	3	2	1	1	3
Germany															1	
Denmark												0	0	1	0	0
Spain*	112	134	138	200	297	129	106	120	80	70	42	40	43	38	30	41
France	2685	2722	2958	3403	3082	3204	3241	2821	2942	2836	2963	2855	2730	3136	2934	2665
UK	171	130	155	171	199	275	315	339	325	331	303	469	376	390	474	405
Ireland			0	1	0	0	0			0	0					
Netherlands					4	9	3	23	26	24	24	22	22	34	74	91
Portugal	44	57	57	41	45	38	43	42	41	17	15	18	55	51	53	64
Total**	3013	3043	3308	3816	3628	3655	3709	3345	3415	3280	3349	3407	3228	3651	3567	3177

*** Data not available for Area 34 and 37 in 2015–2020; ** Includes negligible landings reported to Fishing Area 34 and 37 (ca. 0.0-2.4% of the total annual estimated landings).**

Table 21.3. Smooth-hounds in the Northeast Atlantic. Age-length key for *Mustelus asterias*, based on data given in Farrell *et al.* (2010a).

Age	Total length (cm)	
	Male	Female
0	38.1	34.9
1	49.7	46.9
2	59.3	57.3
3	67.2	66.3
4	73.6	74.1
5	79.0	80.8
6	83.3	86.6
7	86.9	91.6
8	89.9	95.9
9	92.4	99.7
10	94.4	102.9
11	96.0	105.7
12	97.4	108.1
13	98.5	110.2
14	99.4	112.0
15	100.2	113.6
16	100.8	114.9
17	101.3	116.1
18	101.7	117.1

Table 21.4 Smooth-hounds in the Northeast Atlantic. Fecundity at length data for *Mustelus asterias*, based on data given in Henderson *et al.* (2003), Farrell *et al.* (2010b), McCully Phillips and Ellis (2015) and Ellis *et al.* (2019 WD).

Source	Total length (cm)	Uterine fecundity	Maturity stage[3]
Henderson *et al.* (2003)	87	10	D
	89	2	D
	109	10	D
Farrell *et al.* (2010)	83	6	
	90	8	
	91	7	
	92	4	
	94	7	
	97	6	
	97	9	
	100	9	
	103	14	
	104	7	
	106	7	
	106	11	
	108	10	
	111	18	
	112	9	
McCully Phillips & Ellis (2015)	80	4	D
	83	7	D
	86	10	E
	88	9	D
	90	7	D
	91	6	F
	92	6	D
	93	4	F
	96	14	F
	97	9	F
	97	5	E
	97	11	D
	98	10	F
	98	10	D
	101	7	F
	101	11	E
	101	10	F
	101	12	D
	102	11	F

[3] Maturity stage as per described in McCully Phillips and Ellis, 2015.

Source	Total length (cm)	Uterine fecundity	Maturity stage[3]
	103	12	F
	104	13	F
	105	17	F
	105	8	F
	106	11	F
	110	17	F
	115	12	F
	116	20	F
	116	15	E
	124	13	F
Cefas unpublished[4] in Ellis *et al.* (2019 WD)	101	5	F
Cefas (Ciro 2/02) in Ellis *et al.* (2019 WD)	88	4	D
	92	2	D
	93	2	D
	101	9	F
	111	14	F
Cefas trawl surveys (CEnd 2/13) in Ellis *et al.* (2019 WD)	93	4	F
	97	10	E
Cefas trawl surveys (CEnd 4/18) in Ellis *et al.* (2019 WD)	81	3	F
	85	5	F
	87	4	F
	88	4	F
	89	5	F
	89	5	F
	90	4	F
	90	6	F
	91	7	E
	93	8	F
	97	10	F
	99	9	F
	100	12	F
	101	4	F
Cefas trawl surveys (CEnd 3/19) in Ellis *et al.* (2019)	82	6	F
	99	10	F
	100	12	F
	100	9	E
	108	2	D

[4] April 2019, 101 cm, 3671 g total weight

Table 21.5 Smooth-hounds in the Northeast Atlantic. Biomass indices for exploitable biomass (individuals of ≥ 50 cm total length) of starry smooth-hound derived from five surveys (average of NS–IBTS–Q1 and NS–IBTS–Q3, EVHOE–WIBTS–Q4, CGFS–Q4 and IGFS–WIBTS–Q4). The stock size indicator is the annual mean of the normalized surveys indices (2005–2020).

Year	NS–IBTS–Q1 Q3	EHVOE–WIBTS–Q4	CGFS–Q4	IGFS–WIBTS–Q4	Stock size indicator
2005	0.179	0.39	0.72	0.21	0.37
2006	0.52	0.196	1.00	0.26	0.49
2007	1.23	0.59	0.82	0.44	0.77
2008	0.62	1.23	1.01	0.37	0.81
2009	0.60	0.00	1.38	0.40	0.60
2010	0.69	0.00	0.82	0.75	0.57
2011	0.70	0.89	0.60	0.33	0.63
2012	0.74	0.84	0.75	0.61	0.73
2013	0.95	0.27	0.75	0.57	0.63
2014	1.24	1.14	0.57	1.02	0.99
2015	0.62	2.20	1.74	1.59	1.53
2016	0.86	1.99	1.09	2.20	1.54
2017	1.87	NA	0.97	2.50	1.79*
2018	1.08	1.79	0.67	1.41	1.24
2019	2.20	1.69	1.76	2.40	2.00
2020	1.86	1.85	1.34**	0.92	1.49

*** In 2017, the stock size indicator does not include EHVOE–WIBTS–Q4 (Data not available).**
**** Only parts of the survey area covered during CGFS–Q4 though impact considered to be negligible for starry smooth-hound.**

Table 21.6 Smooth-hounds in the Northeast Atlantic. Index ratios based on the mean of the previous two years (Index A: 2019-2020) over the mean of the five preceding years (Index B: 2014 – 2018), depending on the fisheries-independent surveys and data considered. Note: Values as per ICES rounding rules. Option used in the assessment highlighted in bold.

Option	Time-series	Index A	Index B	Ratio A/B
As per advice in 2019 (IBTS-Q1, IBTS-Q3 and EHVOE-WIBTS-Q4)	1997–2020	2.5	1.73	1.43
Combined IBTS (Q1 and Q3) and EHVOE-WIBTS-Q4	1997–2020	2.4	1.88	1.30
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4 and IGFS-WIBTS-Q4	2005–2020	1.82	1.58	1.15
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4, IGFS-WIBTS-Q4 and CGFS-Q4 (incl 2020)	**2005–2020**	**1.76**	**1.42**	**1.24**
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4, IGFS-WIBTS-Q4 and CGFS-Q4 (excl 2020)	2005–2020	1.79	1.42	1.25
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4, IGFS-WIBTS-Q4 and CGFS-Q4 (excl ICES rectangles 29F1 and 30E9)	2005–2020	1.77	1.41	1.25

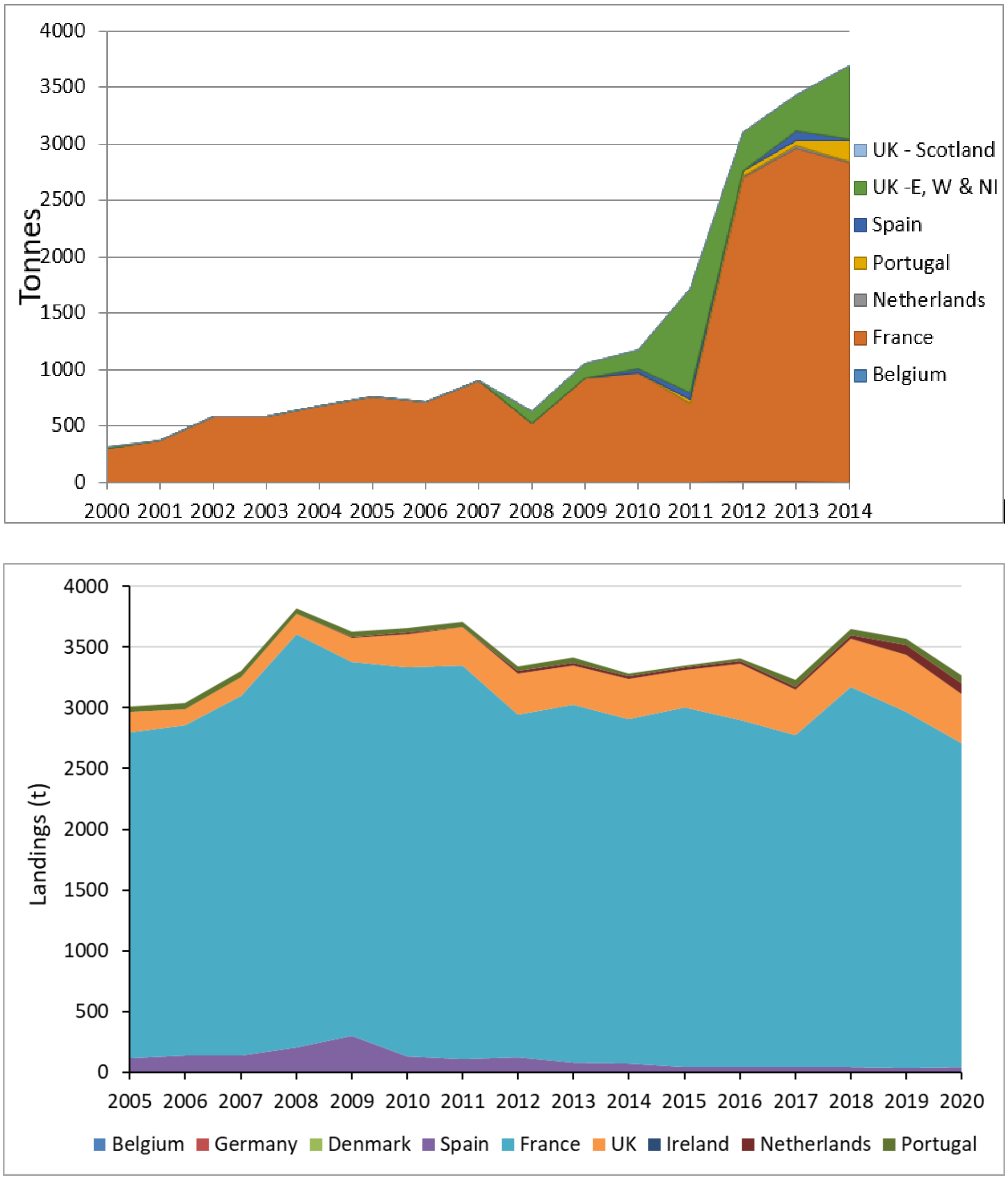


Figure 21.1. Smooth-hounds in the Northeast Atlantic. Earlier ICES estimates of overall *Mustelus* spp. landings by country (2000–2014; top) and revised ICES estimates (2005–2020; bottom). Data are considered underestimates.

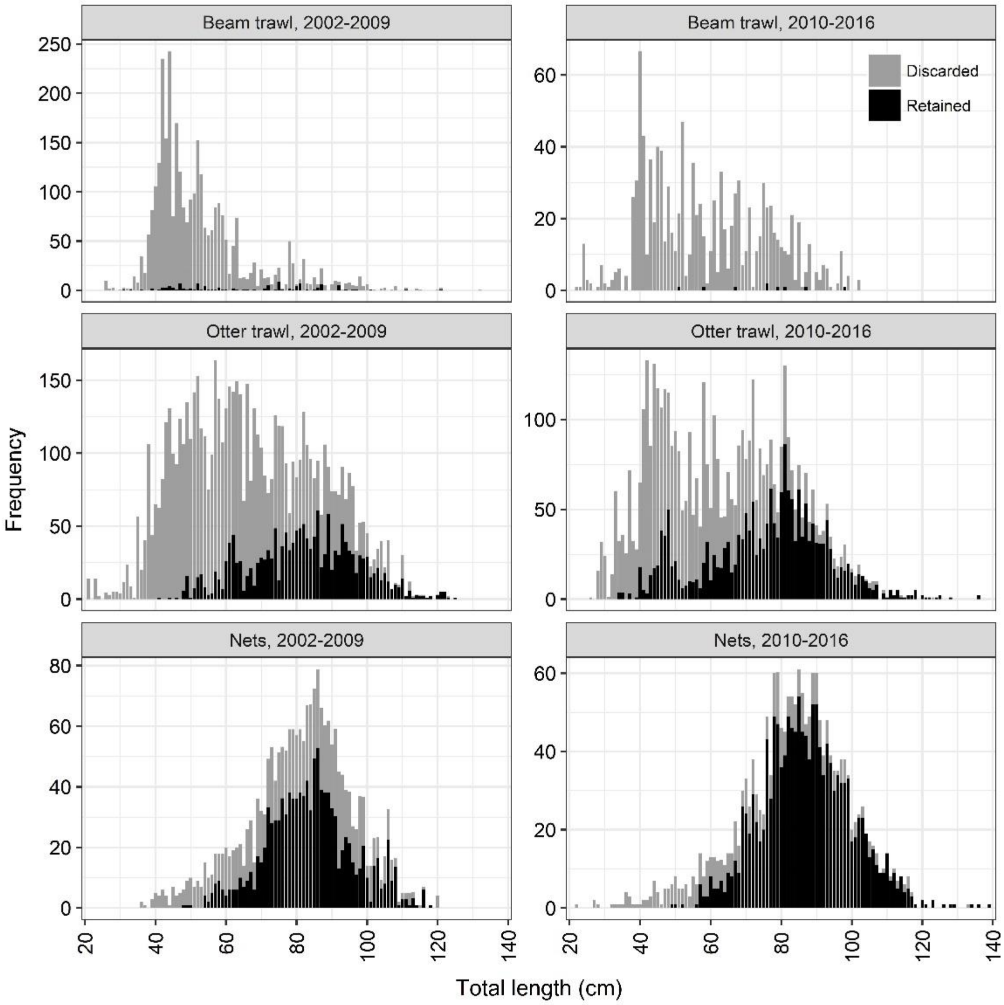


Figure 21.2. Smooth-hounds in the Northeast Atlantic. Length–frequency of discarded (pale grey) and retained (dark grey) starry smooth-hound *Mustelus asterias* caught by beam trawl, otter trawl and gillnets during the periods 2002–2009 and 2010–2016, as recorded in the Cefas observer programme. Data aggregated across North Sea and Celtic Seas ecoregions. (Source: Silva and Ellis, 2019).

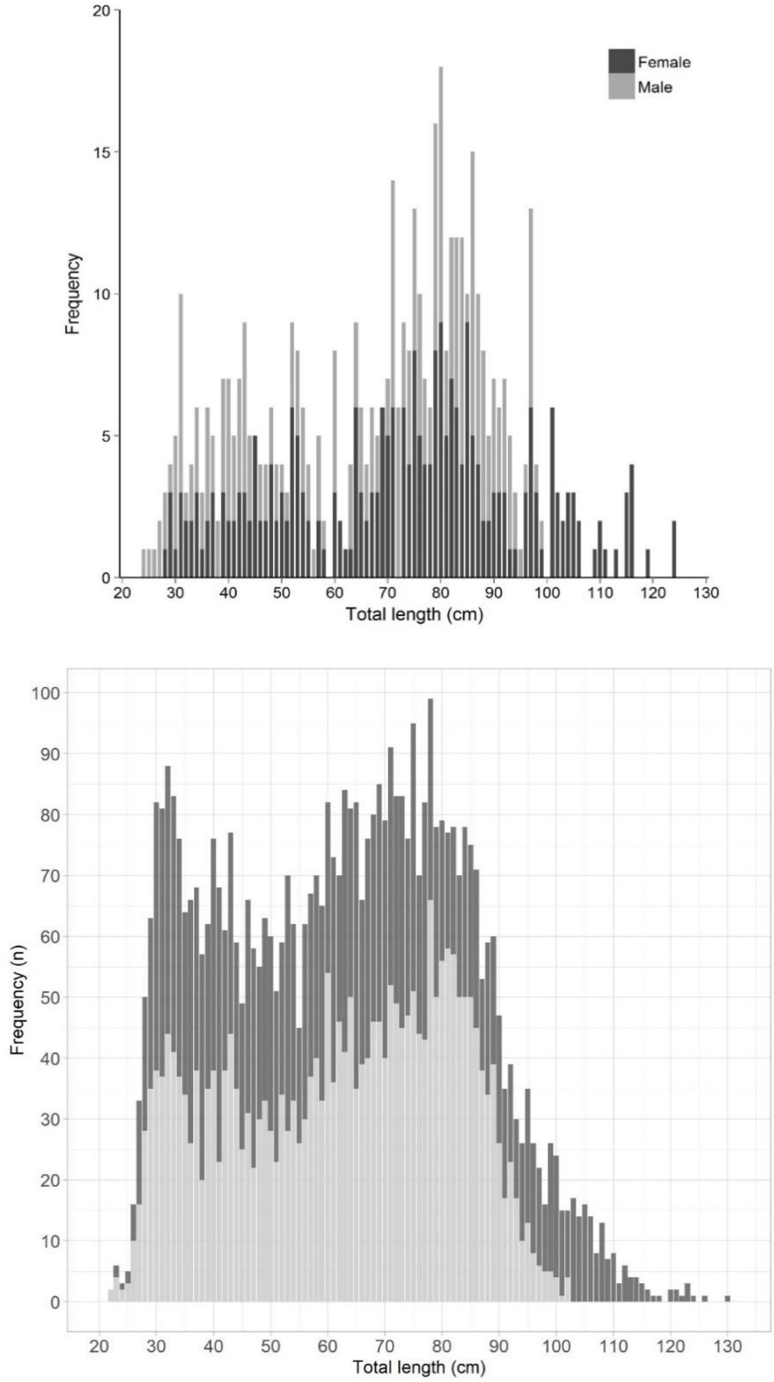


Figure 21.3. Smooth-hounds in the Northeast Atlantic. Number of starry smooth-hounds biologically sampled by length and sex (top) n = 504 from McCully Phillips and Ellis (2015) and (bottom) n = 4951 from Ellis *et al.* (2019 WD).

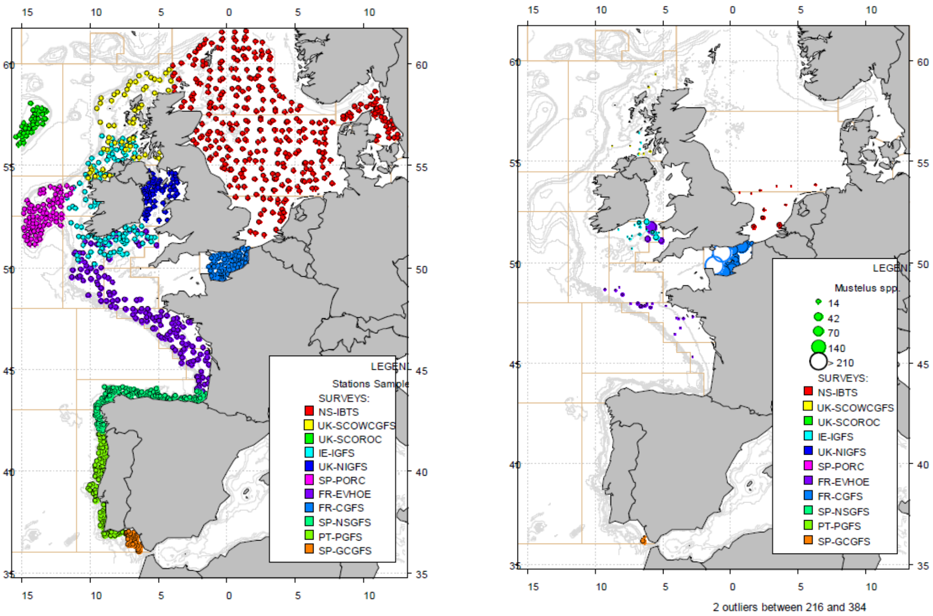


Figure 21.4. Smooth-hounds in the Northeast Atlantic. IBTS hauls undertaken in Q3 and Q4 2015 (left) and corresponding catches of *Mustelus* spp. (right). The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore, the map does not reflect proportional abundance in all the areas but within each survey. Source: ICES (2016b).

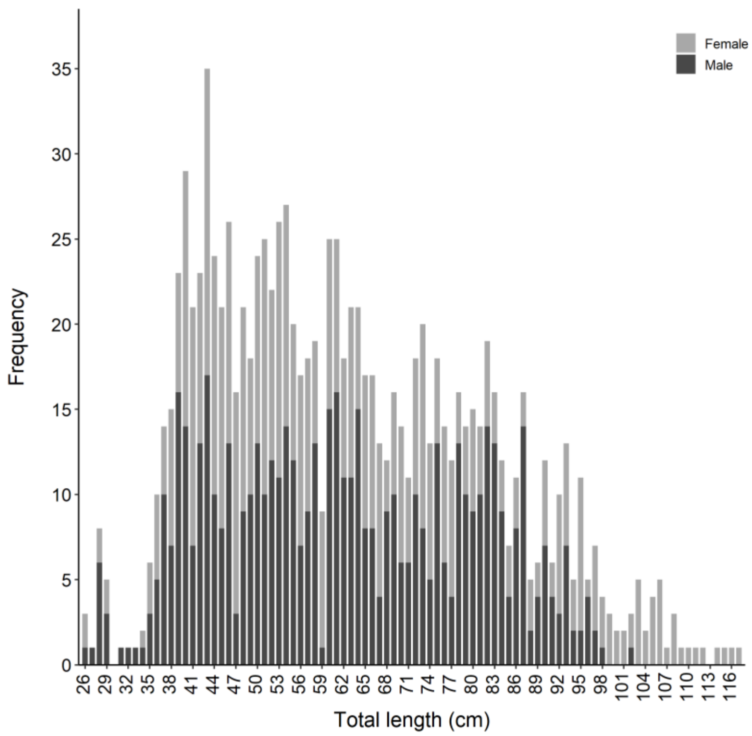


Figure 21.5. Smooth-hounds in the Northeast Atlantic. Length–frequency by sex of smooth-hounds *Mustelus* spp. encountered during the UK Western Channel Q1 Beam-trawl survey 2006–2019 (incorporating the Celtic Sea 2014–2019). Source: Silva *et al*. (2020 WD).

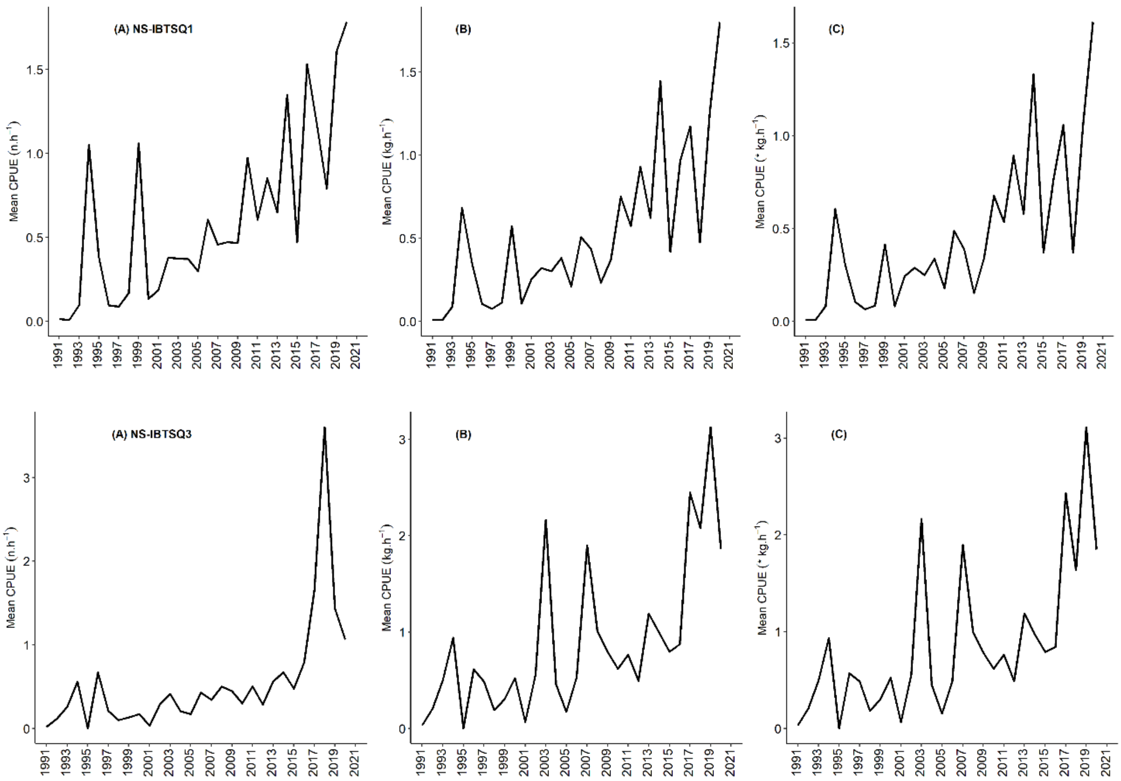


Figure 21.6. Smooth-hounds in the Northeast Atlantic. Survey indices (A - number per hour; B - estimated biomass per hour; and C - estimated exploitable biomass for individuals ≥50 cm total length) in IBTS-Q1 (top) and IBTS-Q3 (bottom) of the North Sea. Note: IBTS-Q3 excludes data for RV *Dana*. Updated survey index in 2021 for whole time series.

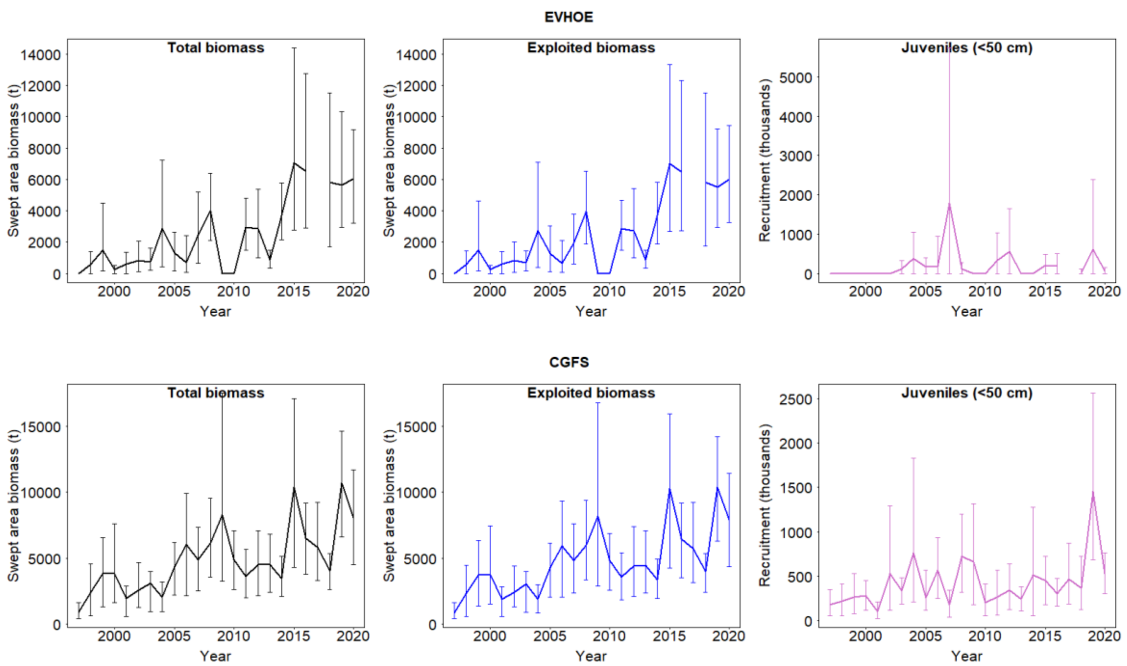
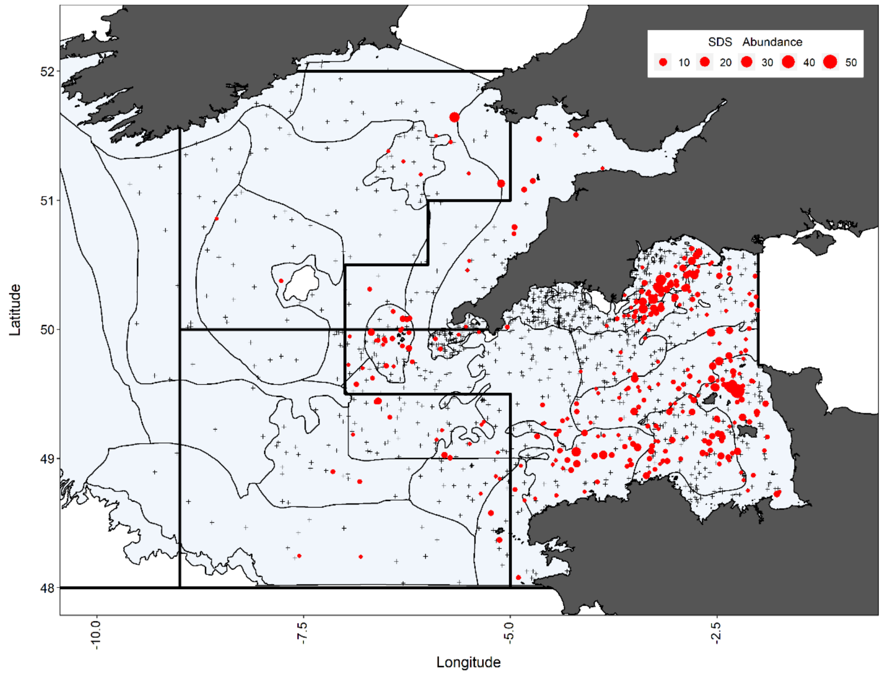


Figure 21.7. Smooth-hounds in the Northeast Atlantic. Swept area exploitable biomass index with 95% confidence intervals from the EVHOE-WIBTS-Q4 survey in divisions 7.g-j, 8.a.b.d (top) and CGFS-Q4 in Division 7.d (bottom). Note: EVHOE-WIBTS-Q4 indices updated in 2021 for whole time series, survey did not occur in 2017. Source: DATRAS.



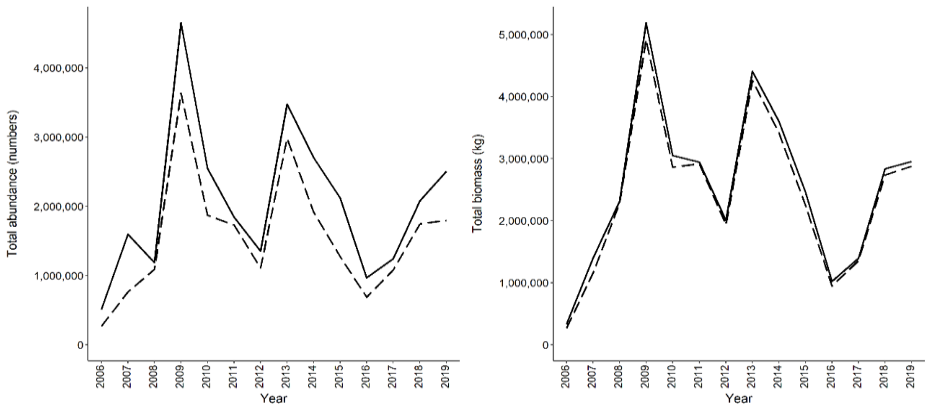


Figure 21.8. Smooth-hounds in the Northeast Atlantic. Survey grid of the UK-Q1SWBEAM survey (2006–2019) indicating the distribution and relative abundance of *Mustelus* spp. (top), and the total abundance (numbers in 7.e) and total biomass (kg in 7.e) for *Mustelus* spp (bottom). Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. Source: Silva *et al*. (2020 WD).

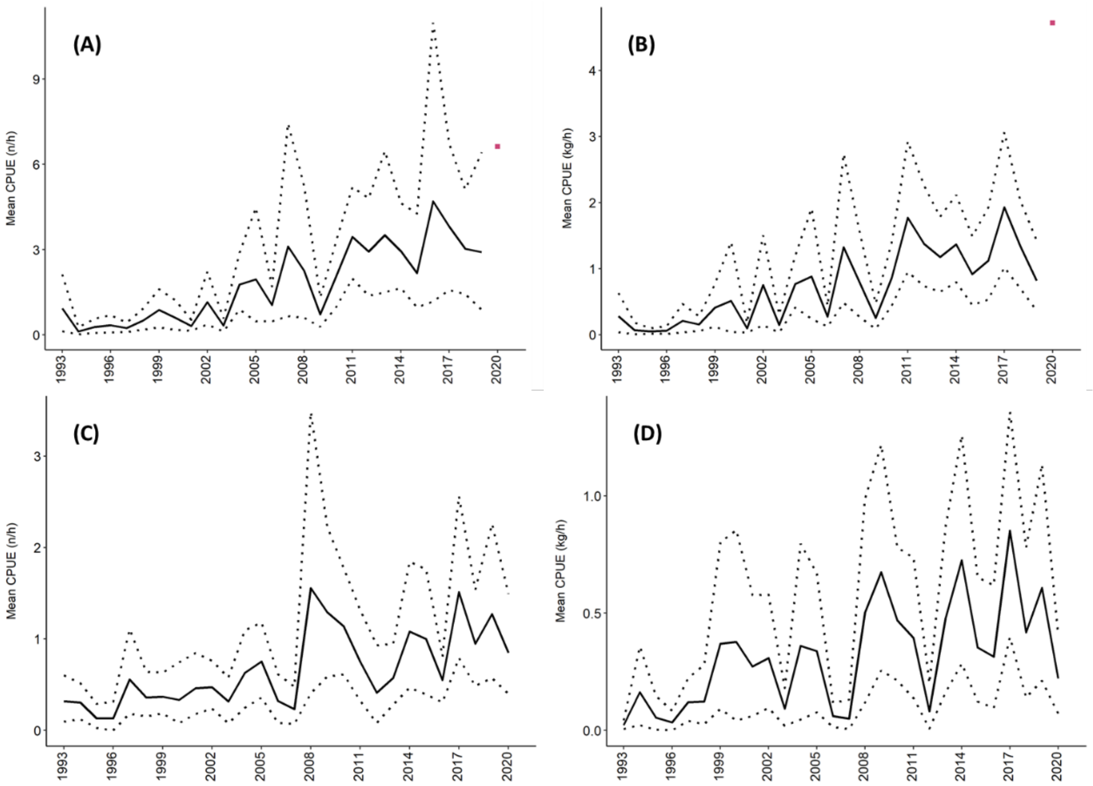


Figure 21.9. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (number per hour for all individuals, estimated total biomass per hour and 95%CI) from BTS-UK (E&W)-Q3 in the Bristol Channel and Irish Sea (top, panel A and B) and BTS-Eng-Q3 in the eastern English Channel and southern North Sea (bottom, panel C and D). Note: 2020 value (top, panel A and B) shown as pink square without 95%CI should be viewed with caution (see Section 21.6.2). Updated survey indices in 2021 for whole time series.

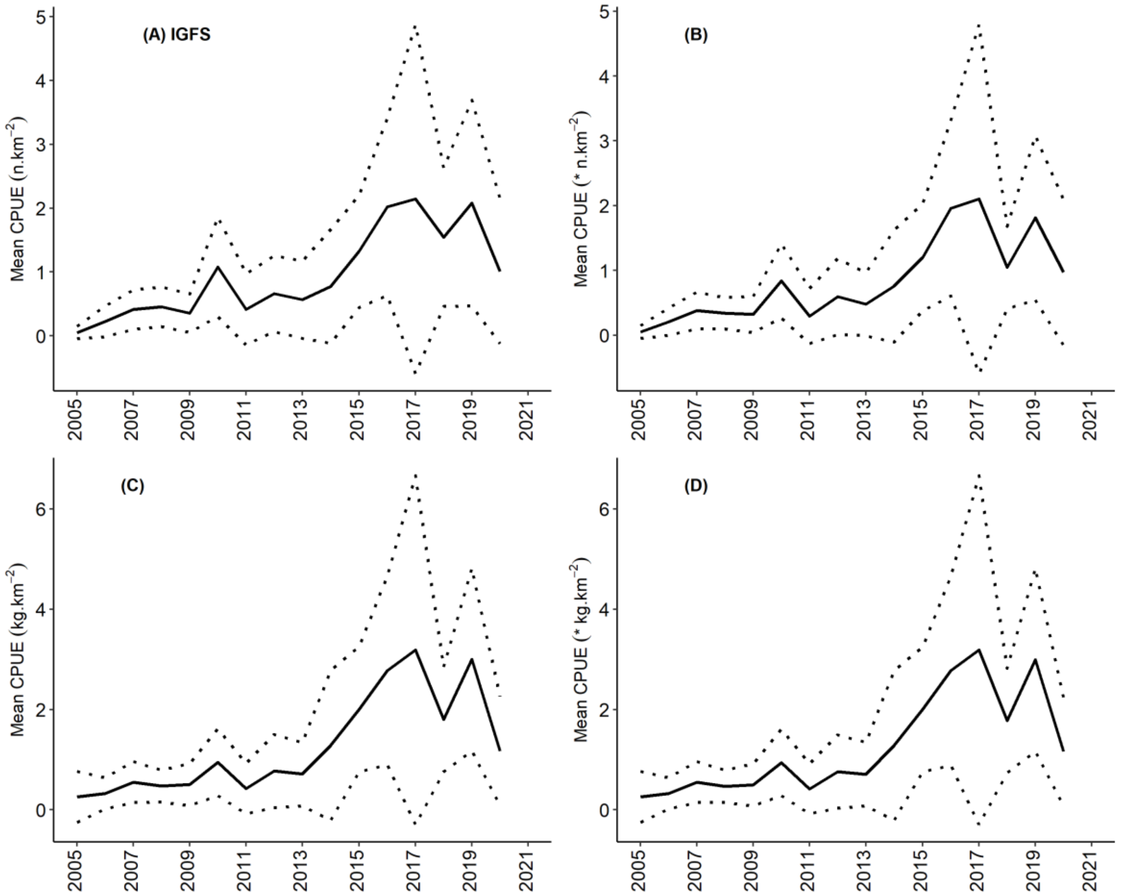


Figure 21.10. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (95%CI) by (A) total abundance (n.km^{-2}), (B) total biomass (kg.km^{-2}), (C) abundance for individuals ≥50 cm total length (*n.km^{-2}) and (D) biomass for individuals ≥50 cm total length (*kg.km^{-2}) from the IGFS-WIBTS-Q4.

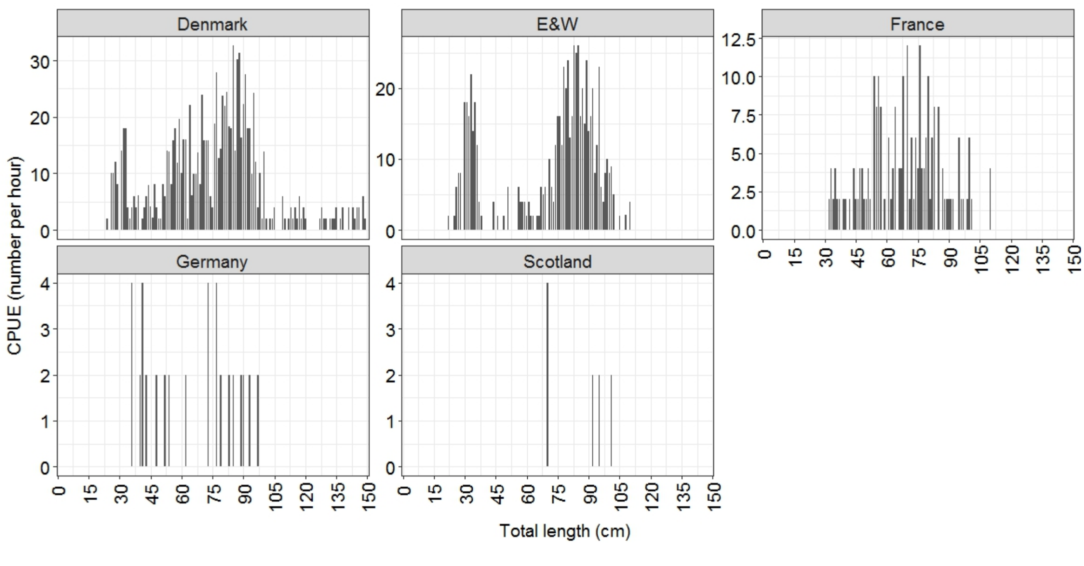


Figure 21.11. Smooth-hounds in the Northeast Atlantic. Length distributions of *Mustelus* spp. in the Q3-IBTS of the North Sea by nation during 1992–2016. Most nations record *Mustelus* spp. up to 110 cm, while Danish data (to 149 cm) suggests there may be misidentification with *Galeorhinus galeus* or coding errors.

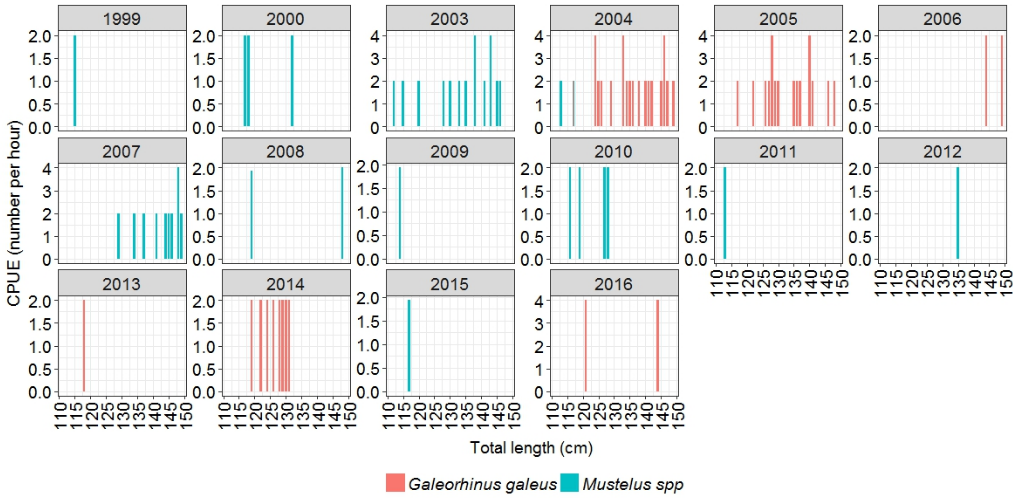


Figure 21.12. Smooth-hounds in the Northeast Atlantic. Length distributions of triakid sharks ≥110 cm as reported on DATRAS during IBTS-Q3 for the RV *Dana* (1992–2016). Large specimens of triakid sharks (i.e. *Mustelus* spp. or *Galeorhinus galeus*) are not usually captured in the same year, which suggests potential identification issues or coding errors.

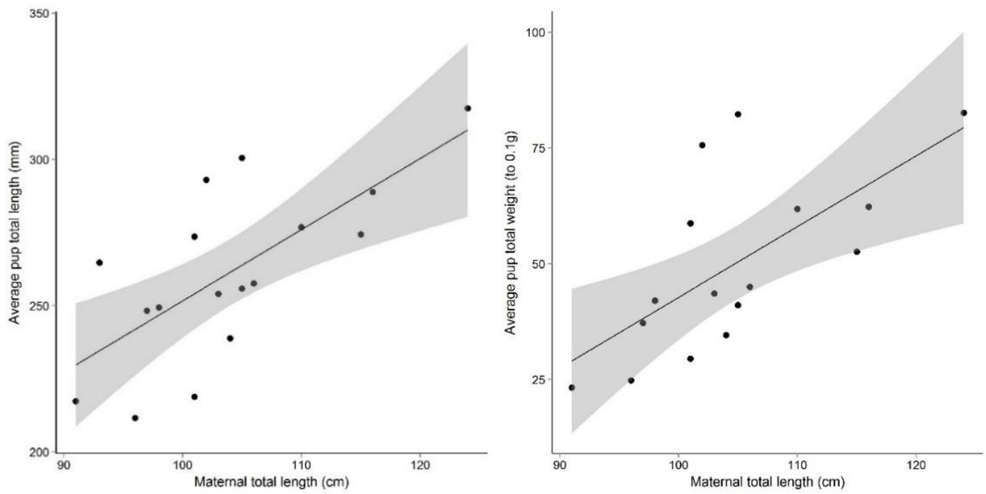


Figure 21.13. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and average length and weight of term pups. Source: McCully Phillips and Ellis (2015).

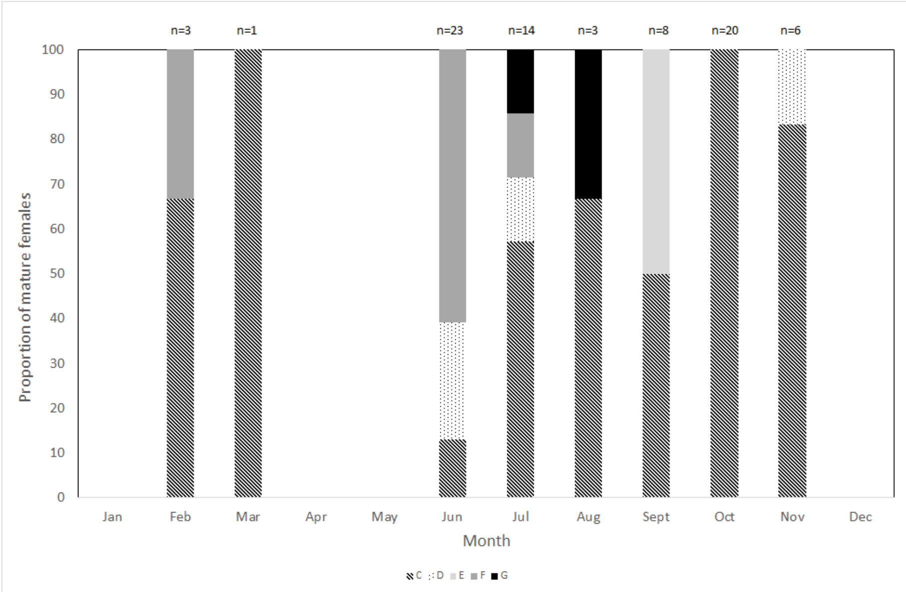


Figure 21.14. Smooth-hounds in the Northeast Atlantic. Percentage of mature females at each developmental stage (D: early gravid; E: mid-gravid; F: late gravid; G: post-partum) by month. Source: McCully Phillips and Ellis (2015).

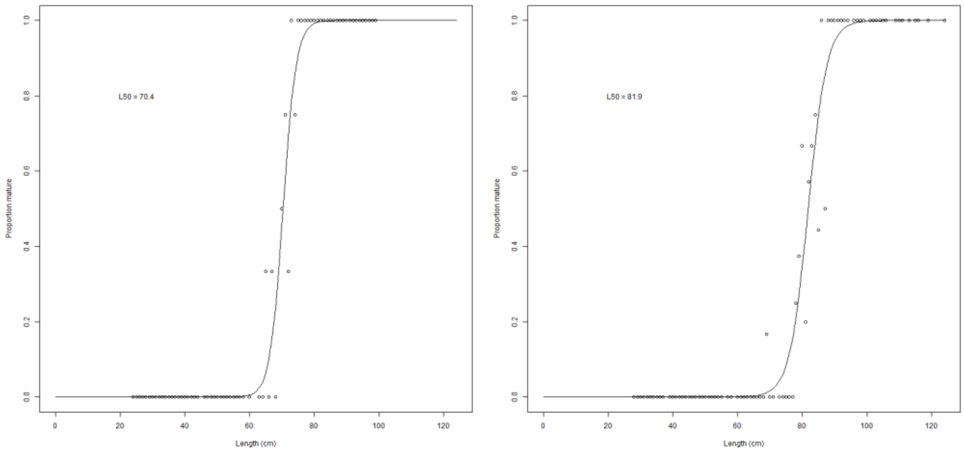


Figure 21.15. Smooth-hounds in the Northeast Atlantic. Maturity ogive for male (n = 237; L_{50} = 70.4 = cm L_T) and female (n = 248; L_{50} = 81.9 cm L_T) *M. asterias*. Source: McCully Phillips and Ellis (2015).

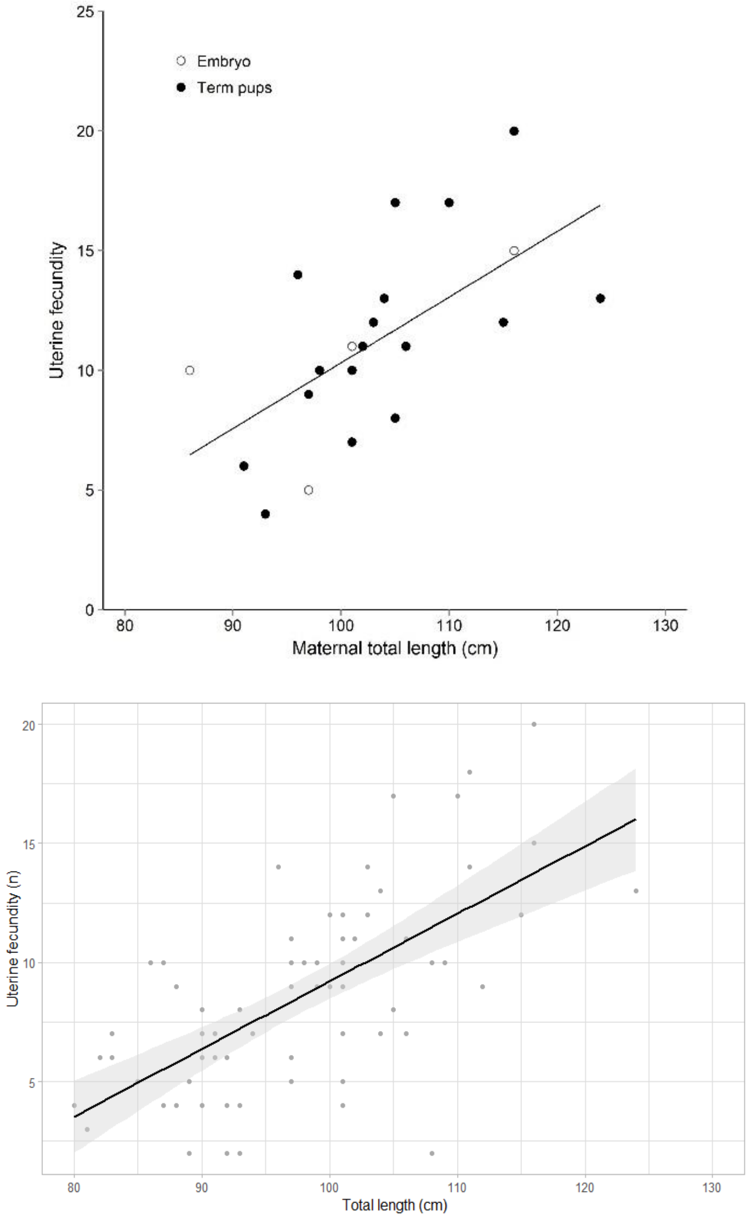


Figure 21.16. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and uterine fecundity (top) from McCully Phillips and Ellis (2015) and (bottom) from Ellis *et al.* (2019 WD).

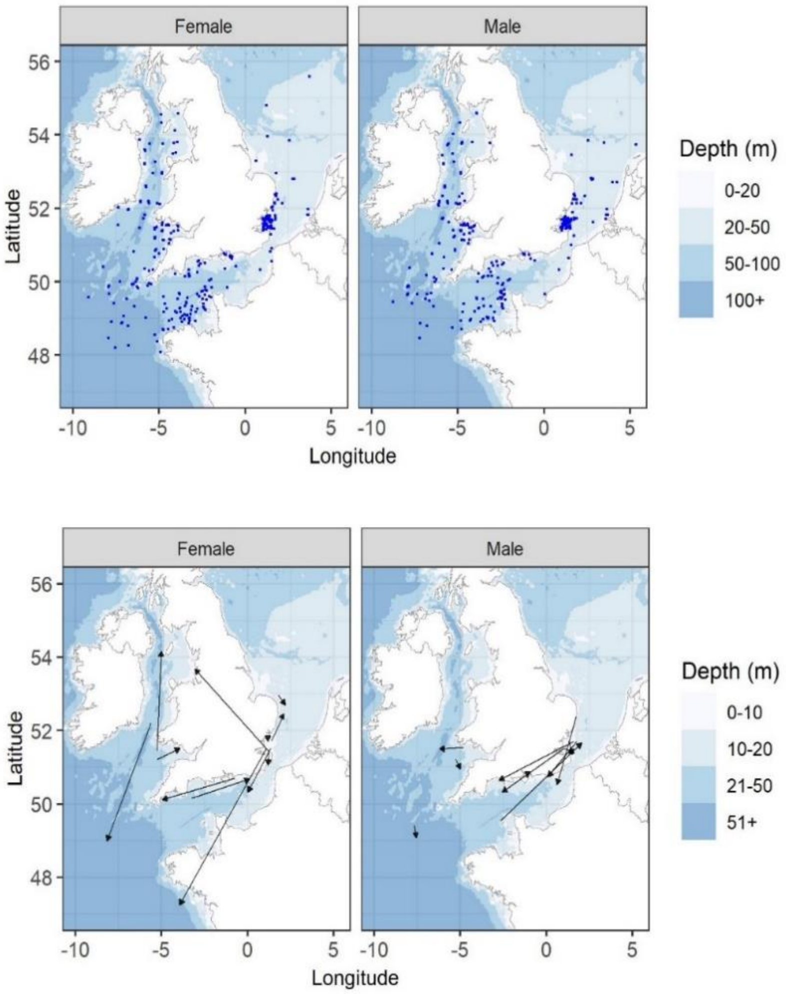


Figure 21.17. Smooth-hounds in the Northeast Atlantic. Tagging locations (top) and displacement vectors (bottom) for male and female *M. asterias*. Source: Ellis *et al.* (2019 WD).

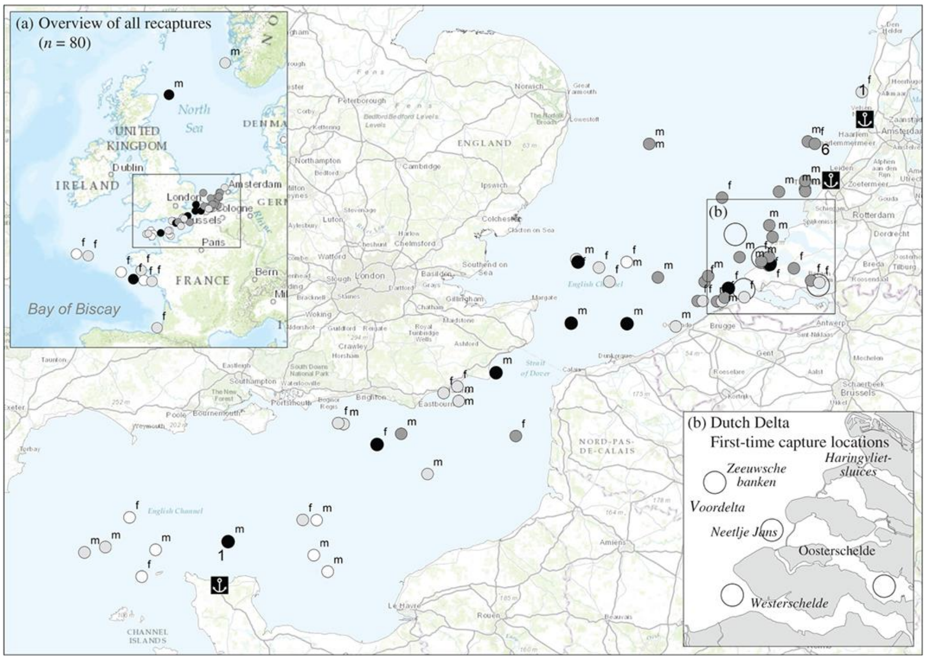


Figure 21.18. Smooth-hounds in the Northeast Atlantic. The main map shows the more detailed distribution of recaptures in the English Channel and southern North Sea. From three fish markets (indicated with anchors), eight tagged *M. asterias* were reported (numbers next to the anchors represent the number of sharks from each fish market) with unknown recapture location. Inset (a) shows the locations of recaptured *Mustelus asterias* (n = 80) reported by quarter for the years 2011–2014. Their distribution pattern indicates a circannual migration between the Dutch Delta (summer), the English Channel and Bay of Biscay (winter). Inset (b) shows the tag and release location with the main places fished indicated with open circles. Symbols: f = female; m = male; recaptures per quarter are shown for January to March (○), April to June (○), July to September (●) and October to December (●). Source: Brevé *et al*. (2016).

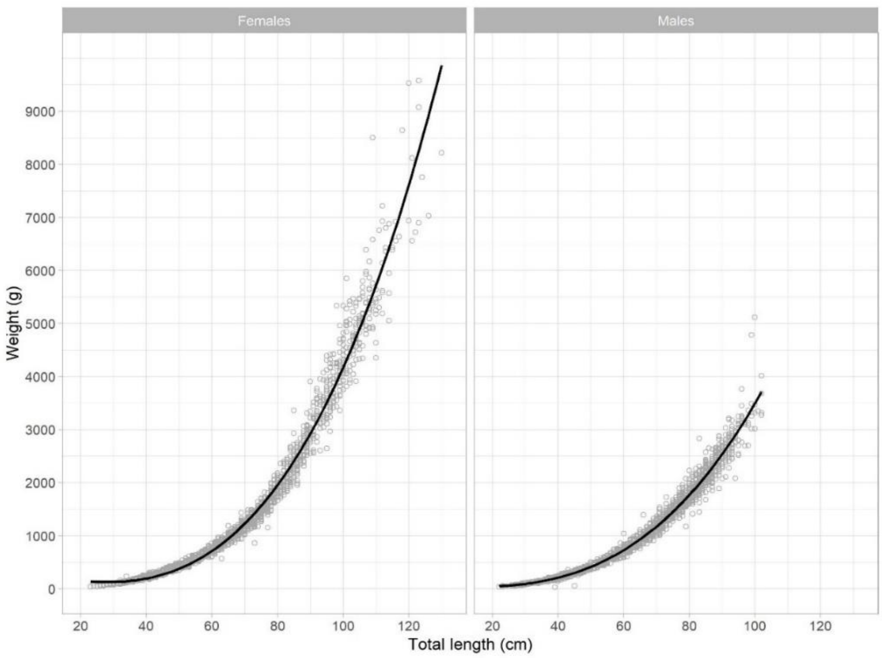


Figure 21.19. Smooth-hounds in the Northeast Atlantic. Length–weight relationships for female and male *M. asterias* caught in fishery-independent trawl surveys conducted by Cefas between 2009–2019. Relationships are described by the equations: females, $M_T = 0.002\ T_L^{3.1}$ ($r^2 = 0.992$, n = 2323); males, $M_T = 0.003\ T_L^{3.0}$ ($r^2 = 0.991$, n = 2471). M_T = Total weight (g), L_T = Total length (cm). Source: Ellis *et al*. (2019 WD).

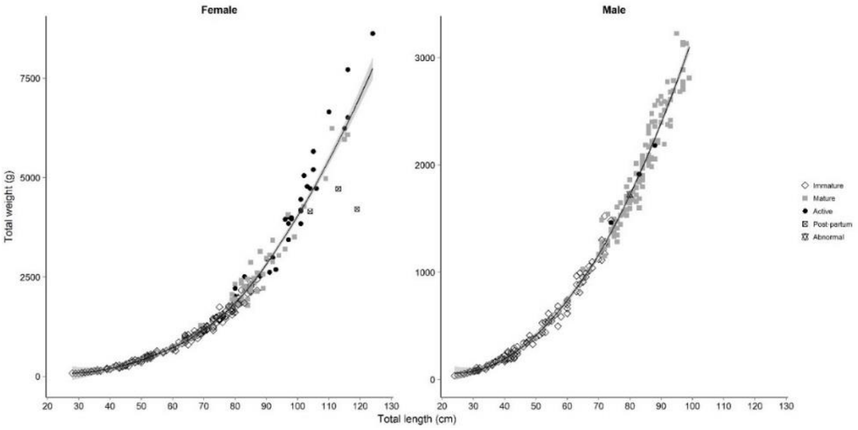


Figure 21.20. Smooth-hounds in the Northeast Atlantic. Length–weight relationship for female (n = 248) and male (n = 237) *M. asterias* by maturity stage (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015).

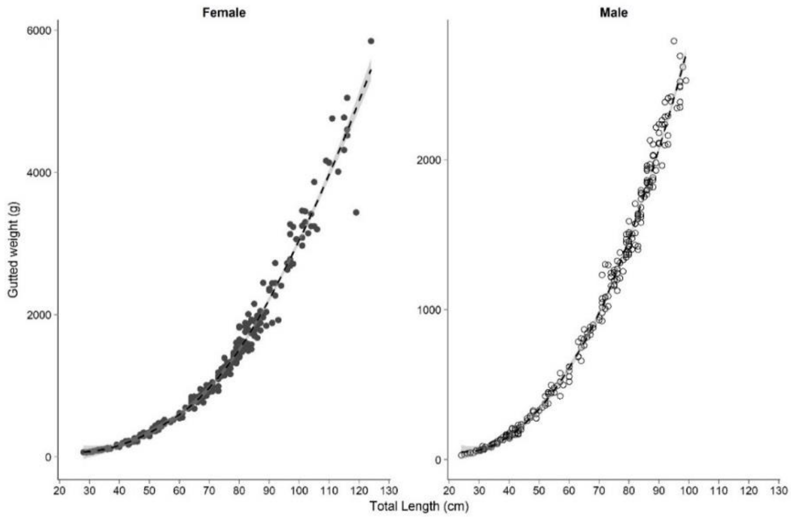


Figure 21.21. Smooth-hounds in the Northeast Atlantic. Total length to gutted weight relationship for female (n = 249) and male (n = 235) *M. asterias* (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015).

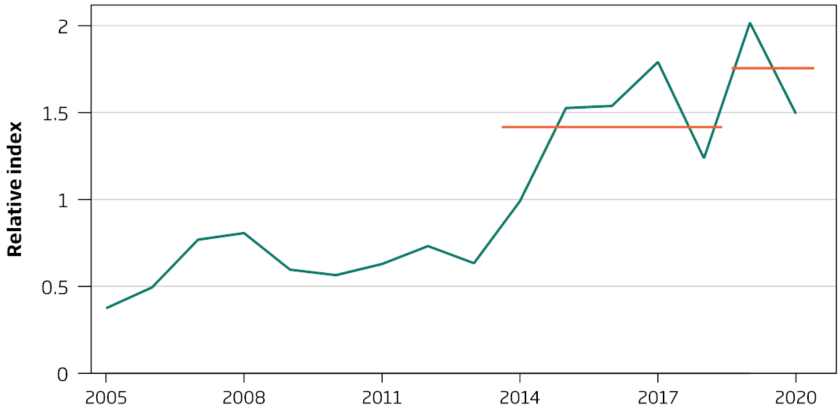


Figure 21.22. Smooth-hounds in the Northeast Atlantic. Stock size indicator is the mean normalized exploitable biomass index (individuals of ≥ 50 cm total length) of starry smooth-hound from the average of the two NS-IBTS surveys (NS–IBTS–Q1 and NS–IBTS–Q3), EVHOE–WIBTS–Q4, CGFS–Q4 and IGFS–WIBTS–Q4. The horizontal lines show the average of the most recent two-years (2019–2020) and the preceding five-years (2014–2018).

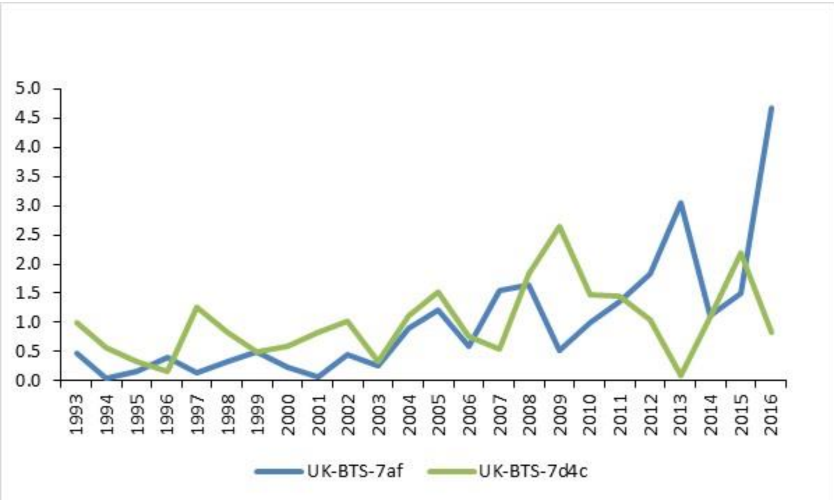


Figure 21.23. Smooth-hounds in the Northeast Atlantic. Annual catch rate of pups (<35 cm) in the BTS-UK (E&W)-Q3 (Bristol Channel and Irish Sea) and BTS-Eng-Q3 (eastern English Channel and southern North Sea) for the years 1993–2016, each standardised to the long-term mean for the survey.

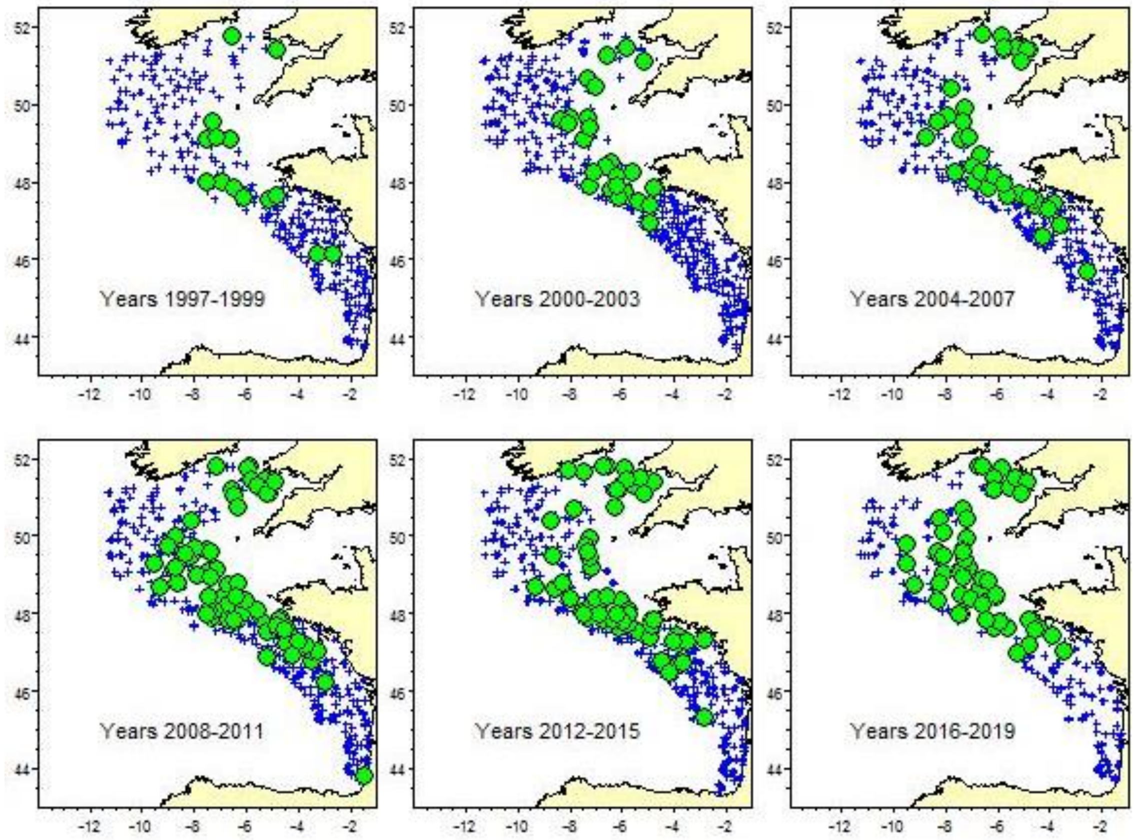


Figure 21.24. Smooth-hounds in the Northeast Atlantic. Distribution of occurrences of *Mustelus* spp. (green points) in the EVHOE-WIBTS-Q4 survey (1997–2019) by groups of 4 years. Source: National data (Ifremer) .

Figure 21.25. Smooth-hounds in the Northeast Atlantic. Normalized survey indices for starry smooth-hound (individuals ≥50 cm total length) for combined IBTS-Q1 and Q3, EVHOE-WIBTS-Q4, CGFS-Q4 (with 2020), CGFS-Q4 (excl 2020), CGFS-Q4 (excl ICES rectangles 29F1 and 30E9) and IGFS-WIBTS-Q4 (top), and different scenarios for stock size indicators for 2005–2020 (bottom).